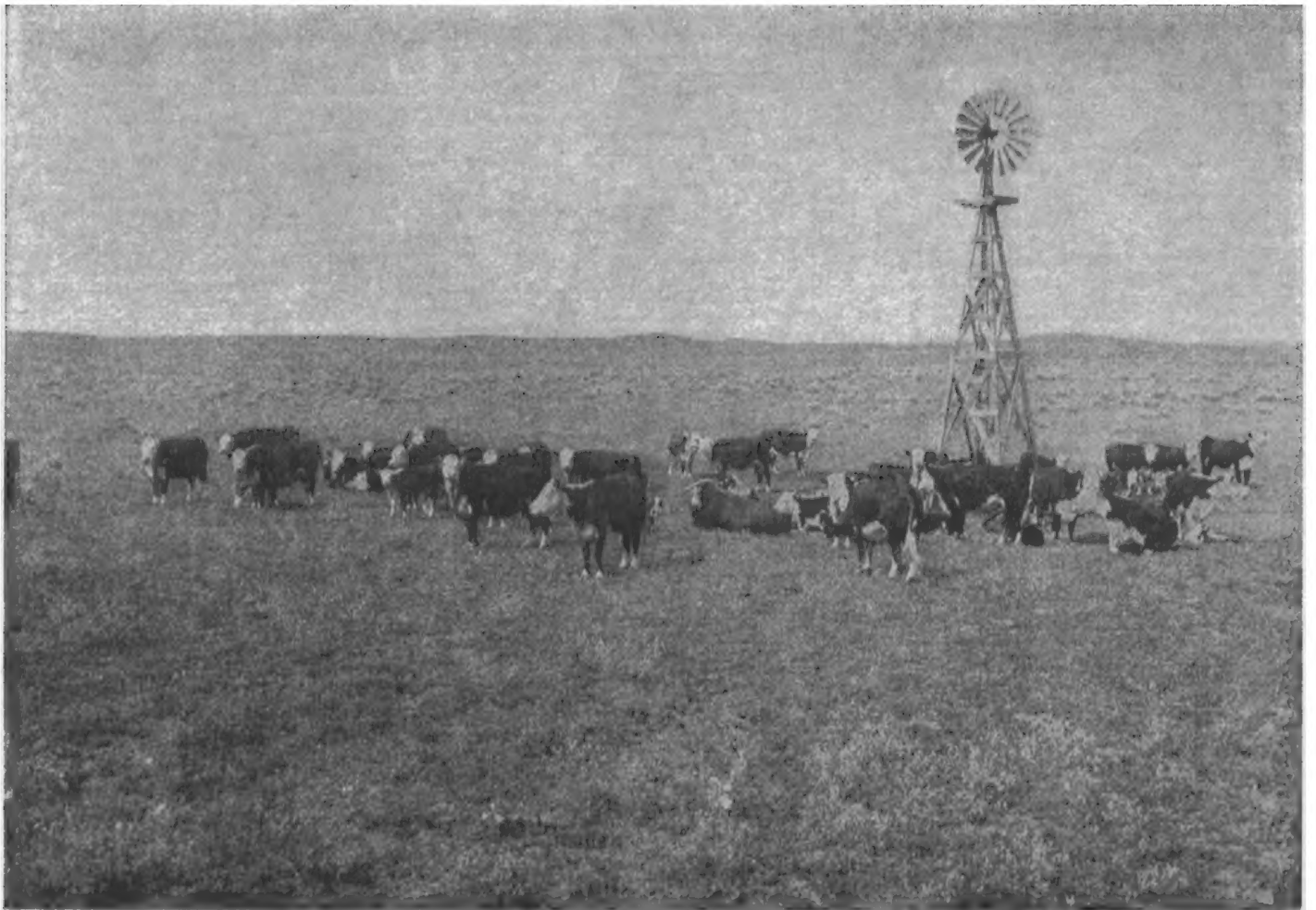


SOIL SURVEY

Dundy County Nebraska



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
UNIVERSITY OF NEBRASKA
CONSERVATION AND SURVEY DIVISION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Dundy County, Nebraska, will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; and add to our general knowledge about soils.

Soil scientists studied and described the soils and made a map that shows the kinds of soil everywhere in the county. This map, at the back of this report, was made from a set of aerial photographs on which woods, roads, and many other landmarks can be seen.

Locating the soils

Use the index to map sheets to locate areas on the soil map. The index map shows the location of each sheet on the soil map. When you have found the map sheet that shows the area in which you are interested, it will be seen that the boundaries of the soils are outlined and that there is a symbol for each soil. Suppose, for example, an area on the soil map has the symbol A₀AW. The legend for the detailed map shows that this symbol identifies Anselmo loamy fine sand, 0 to 3 percent slopes. This soil and all others mapped in the county are described in the section "Descriptions of Soils."

Finding information

Different sections of this report will interest different groups of readers. The section "General Nature of the County," which mentions settlement and population, cultural facilities, water supply, and climate, and gives some statistics on agriculture, will be of interest mainly to those not familiar with the county.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of Soils," and then turn to the section "Use and Management of Soils." In this way they first identify the soils on their farm or ranch, and then learn how these soils can be managed and what yields can be expected. The soils are

grouped by capability units; that is, groups of soils that need similar management and respond in about the same way. For instance, Anselmo fine sandy loam, 1 to 3 percent slopes, is shown to be in capability unit IIIe-3, when dry farmed. The management this soil needs will be stated under the heading "Capability unit IIIe-3, Dryland" in the section "Use and Management of Soils." The Guide to Mapping Units, Capability Units, Range Sites, and Woodland Sites, which is at the end of the report, will simplify use of the map and the report. This guide gives the map symbol for each soil, the name of the soil, and the page on which the soil is described; the capability unit and the page on which it is described; the woodland site and the page on which it is described; and the range site and the page on which it is described.

Foresters and others interested in woodland can refer to the section "Woodland and Windbreaks." In that section the kinds of trees in the county are mentioned and factors affecting management of woodland or windbreaks are explained.

Rangemen and ranchers interested in grassland can refer to the section "Use and Management of Rangeland." In that section the kinds of grasses in the county and the factors affecting the management of rangeland and of native hay meadows are explained.

Engineers will want to refer to the section "Engineering Properties of Soils." Tables in that section list those characteristics of the soils that affect engineering.

Soil scientists and others interested in the nature of soils can learn how the soils were formed and how they are classified in the section "Soil Formation and Classification."

* * * * *

This soil survey was made as a part of the technical assistance the Soil Conservation Service furnishes to the Dundy Soil and Water Conservation District. Fieldwork for this survey was completed in 1959. Unless otherwise indicated, all statements refer to conditions in the county at the time the survey was made.

Cover picture

Hereford cattle at watering time, Dundy County, Nebr.

Contents

How soils are named, mapped, and classified	1	Descriptions of soils—Continued	Page
General soil map	2	Bridgeport series.....	54
1. Valentine soil association: Soils of sandhills.....	2	Canyon series.....	55
2. Elsmere-Dunday soil association: Sandy soils and sand-caliche soils of the subirrigated upland valleys.....	2	Colby series.....	56
3. Anselmo-Keith soil association: Sandy soils, silty soils, and sand-caliche soils of upland valleys and hills.....	3	Dunday series.....	56
4. Colby soil association: Silty soils of loess hills and canyons.....	3	Elsmere series.....	57
5. Keith soil association: Silty soils of loess upland plains.....	3	Gannett series.....	58
6. Bridgeport-Havre soil association: Loamy soils of valley-fill foot slopes and high bottom lands.....	5	Glendive series.....	58
7. Sandy alluvial land-Las soil association: Sandy and loamy soils of river lowlands.....	5	Goshen series.....	59
Use and management of soils	9	Havre series.....	59
Basic management practices.....	9	Keith series.....	60
Conserving moisture.....	9	Las series.....	63
Controlling wind erosion.....	10	Las Animas series.....	63
Applying fertilizer.....	11	Laurel series.....	64
Selecting suitable crops.....	11	Ovina series.....	65
Irrigating.....	11	Platte series.....	65
Capability groups of soils.....	12	Rauville series.....	66
Dryland capability groupings.....	12	Rough broken land.....	66
Irrigated capability groupings.....	13	Scott series.....	67
Estimated yields.....	19	Ulysses series.....	67
Use and management of rangeland.....	22	Ulysses series, clay substratum variant.....	68
Range sites and condition classes.....	24	Valentine series.....	69
Principles of managing rangeland.....	24	Vebar series.....	70
Proper degree of use.....	28	Soil formation and classification	70
Proper kinds of livestock.....	28	Factors of soil formation.....	70
Range seeding.....	29	Climate.....	71
Controlling blowouts.....	29	Plant and animal life.....	71
Management of native meadows.....	30	Parent material.....	71
Woodland and windbreaks.....	31	Relief.....	72
Windbreaks.....	31	Time.....	72
Woodland sites.....	32	Classification of soils.....	73
Maintaining plantings.....	32	Soil orders.....	73
Wildlife.....	35	Great soil groups.....	74
Conservation of wildlife on farms.....	35	Chestnut soils.....	74
Plantings for wildlife habitats.....	35	Chernozems.....	75
Engineering properties of soils.....	36	Humic Gley soils.....	75
Soil test data and engineering soil classification.....	36	Planosols.....	76
Soil test data.....	36	Solonchak soils.....	76
Engineering classification of soils.....	37	Alluvial soils.....	76
Soil engineering interpretations.....	40	Lithosols.....	77
Planning engineering soil surveys.....	46	Regosols.....	77
Descriptions of soils	47	Mechanical and chemical analyses of soils.....	77
Alluvial land.....	50	Field and laboratory methods.....	77
Anselmo series.....	51	Profile descriptions of the soils analyzed.....	80
Banks series.....	52	General nature of the county	81
Bayard series.....	53	Settlement and population.....	81
Blown-out land.....	54	Transportation and markets.....	81
		Cultural and recreational facilities.....	81
		Water supply.....	82
		Climate.....	82
		Agriculture.....	84
		Literature cited	85
		Glossary	85
		Guide to mapping units, capability units, range sites, and woodland sites	following 86

SOIL SURVEY OF DUNDY COUNTY, NEBRASKA

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE UNIVERSITY OF NEBRASKA,
CONSERVATION AND SURVEY DIVISION

DUNDY COUNTY is in the southwestern corner of Nebraska (fig. 1). The county is about 38½ miles from east to west, and 24 miles from north to south. The total area is 589,440 acres. Livestock raising and dryland production of grain are the main enterprises.

How Soils Are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in Dundy County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Anselmo and Keith, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Many soil series contain soils that are alike except for the texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Anselmo fine sandy loam and Anselmo loamy fine sand are two soil types in the Anselmo series. The difference in texture of their surface layer is apparent from their names.

Some soil types vary so much in slope, degree of ero-

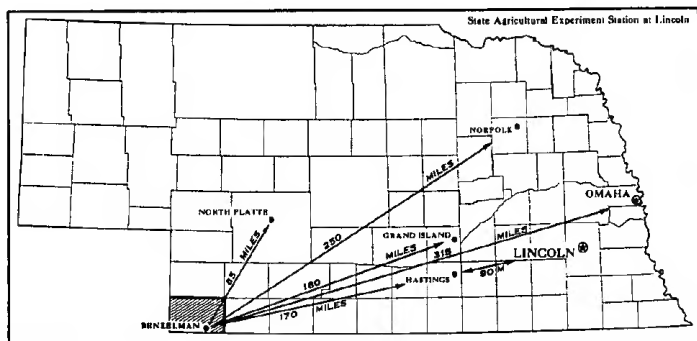


Figure 1.—Location of Dundy County in Nebraska.

Sandhills, used mostly for grazing, make up more than one third of the county, and they are prominent throughout the western half north of the Republican River. Scattered through the sandhills are bodies of sandy, sub-irrigated soils that support good grass and are used mostly for grazing or hay. In the sandhill area there are also bodies of sandy or silty (floury) soils of the upland valleys and hills; these soils are fairly well suited to crops and are used for corn, wheat, sorghum, and other crops. Just east of the middle part of the county there are large bodies of the soils of the upland valleys and hills; they enclose smaller bodies of sandhills.

In the northeastern and southeastern corners of the county are silty, nearly level Keith soils on the tablelands and shallower, silty Colby soils on the hills and in canyons that slope to the drainageways. Along the Republican River there are soils of the bottom lands, which are used mostly for grazing, and soils of the high bottoms and foot slopes, which are used mostly for general farming.

Soil patterns in the county are described further in the section "General Soil Map."

sion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Anselmo fine sandy loam, 9 to 30 percent slopes, is one of several phases of Anselmo fine sandy loam, a soil type that ranges from level to steep.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photographs for their base map because they show woodland, buildings, field borders, trees and similar details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientist has a problem of delineating areas that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Blown-out land or Broken alluvial land, and are called land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units, and had shown the location of the mapping units on the soil map. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

To do this efficiently, he had to consult with persons in other fields of work and jointly prepare with them groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing the short-lived crops and tame pasture; range sites, for those using large tracts of native grass; woodland suitability groups, for those who need to manage wooded tracts or plant windbreaks; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

After study of the soils in a locality and the way they are arranged, it is possible to make a general soil map that shows several main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils, in a pattern that is characteristic, although not strictly uniform.

The soils within any one association are likely to differ

greatly among themselves in some properties; for example, slope, depth, stoniness, or natural drainage. Thus, the general map does not show the kind of soil at any particular place, but patterns of soils. Each pattern may contain several different soils.

The associations are named for the major soil series in them, but as already noted, soils of other series may also be present. The major soil series of one soil association may also be present in other associations, but in a different pattern, and normally in a different proportion.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use.

1. Valentine soil association: Soils of sandhills

This soil association is a succession of sand ridges, hummocks, or hills ranging from about 5 to 75 feet high (fig. 2). Most of the rain soaks into the porous soils, and the surplus moisture escapes through the deep sand. There are no established drainage channels. This association contains about 231,000 acres.

Valentine fine sand, rolling, is on the smooth hummocks and occupies about 90 percent of this association. It is deep and sandy and has only a thin surface layer slightly darkened by organic matter.

Valentine fine sand, hilly, is in rough, irregular, high positions that are passable only on foot or on horseback. It occupies about 8 percent of this soil association. It is deep and sandy but has a thinner surface layer than Valentine fine sand, rolling. Some active wind erosion has occurred on the high caps of the hills.

About 2 percent of this association consists of Dunday soils in nearly level, small valleys and blown-out areas scattered throughout the hills.

The soils of this association are best suited to grass. They are droughty and low in fertility. Their loose, porous surface layer and subsoil absorb water so rapidly that there is little runoff and evaporation. Needle-and-thread, little bluestem, switchgrass, sand bluestem, prairie sandreed, and other prairie grasses are adapted because their deep roots can extract moisture and nutrients from these porous soils.

The soils of this association are subject to blowing. Land that is overgrazed or trampled too frequently by livestock begins to blow, and then special treatment is needed to control erosion. Plowing the very sandy soils invites trouble from blowing. The grass cover, though well established in most places, is sparse and does not entirely prevent wind erosion.

The soils of this association are used for grazing cattle. Ranches generally are only partly on this association. The ranch holdings normally include parts of the Elsmere-Dunday or the Anselmo-Keith soil associations, where wild hay, alfalfa, and forage sorghum are produced. The ranches average about 2,000 acres, though the range is from 600 to 22,000 acres. A high percentage of the holdings are owner operated.

The population on this soil association is sparse. Only a few good roads pass through, but trails are common. Good well water is available almost anywhere in the association.

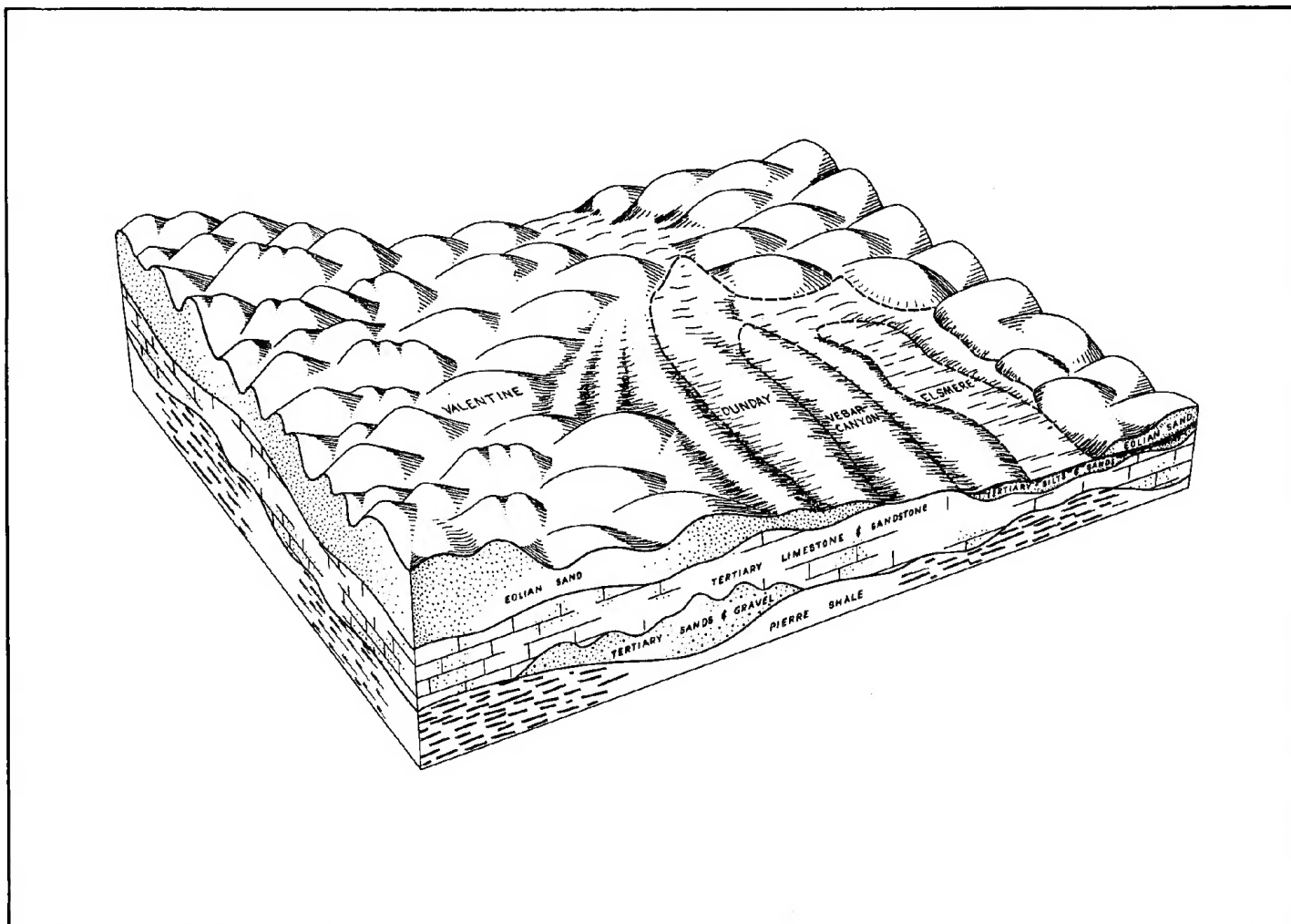


Figure 2.—Typical area in the Valentine soil association.

2. Elsmere-Dunday soil association: Sandy soils and sand-caliche soils of the subirrigated upland valleys

The soils in this association occur in the northwestern part of the county. (See fig. 2.) They are in nearly level to gently sloping, disconnected, upland valleys that are surrounded by very sandy soils of the Valentine association. There is about 28,000 acres in this association.

With the extensive Elsmere and the Dunday soils are small acreages of the Ovina, Vebar, Anselmo, Valentine, and Gannett soils.

The Elsmere soils are in the lower parts of the valleys. They are deep and have a thin surface layer of fine sandy loam and a very sandy subsoil. They have a water table 2 to 6 feet below the surface.

The Dunday soils are in the valleys, in places where drainage is better than for the Elsmere soils. They are deep and have very sandy layers. Some of the Dunday soils have loam material beneath them. This finer textured material consists of an old, buried surface layer or of weathered caliche, which is locally called "magnesia."

Most of the soils in this association are slightly darker and contain a larger proportion of finer particles than the soils of the more rolling and hilly Valentine association. They are, however, considered as very sandy soils. They are excellent for pasture or meadow. Precipitation soaks into the soils rapidly, and underground water supplies additional moisture for deep-rooted grasses.

Under good grass cover, the soils in this association are easily managed, but if they are cultivated, extreme care is required to keep them from blowing.

These soils are used for grazing and raising of wild hay, alfalfa, and forage sorghum. They supplement the grazing land of the Valentine association. Good-quality underground water is abundant.

3. Anselmo-Keith soil association: Sandy soils, silty soils, and sand-caliche soils of upland valleys and hills

This association occurs in well-drained upland valleys and on hills (fig. 3). It is often called the "sand-loess transitional area" because the soils in it are made up of sandy materials and of silty loessal materials. Hard sandstone or limestone caliche is exposed on almost ver-

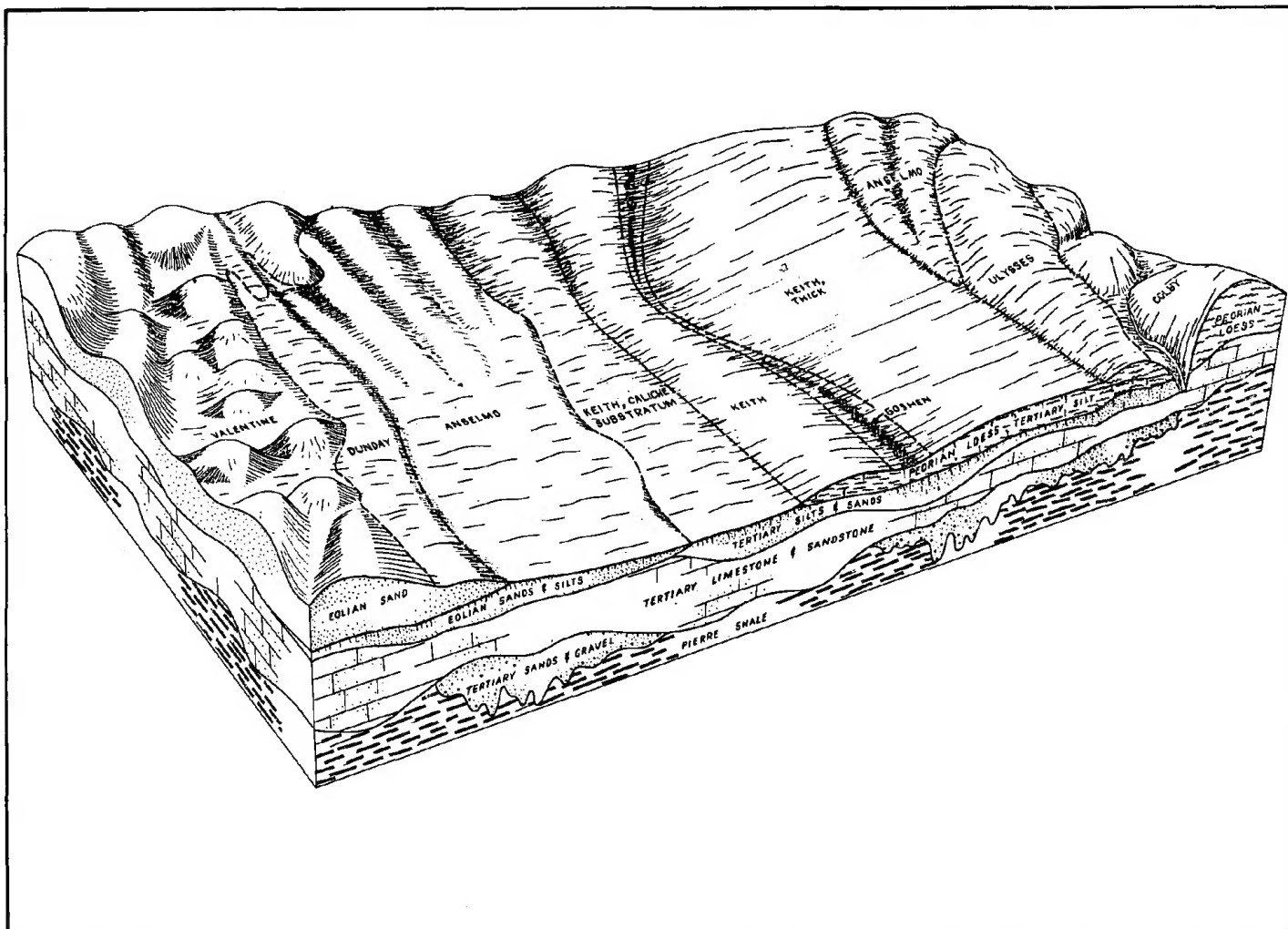


Figure 3.—Typical area in the Anselmo-Keith soil association.

tical cliffs in the upper drainageways of Rock Creek and Rock Canyon. Soft, weathered caliche underlies most of the well-drained valleys at various depths.

The largest acreage in this association occurs north and west of the town of Benkelman. The total association covers about 169,000 acres. The typical topography is undulating or wavy, but broad flats and valleys are included, as are steeper hills along the creeks. One feature that might not be noticed on the ground is the northwest-southeast trend of the ridges, swales, valleys, and creeks. There are no definite drainage channels, except the major spring-fed creeks that drain to the Republican River.

The principal soils in this association are Anselmo and Keith. Some acreages of Dunday, Valentine, Goshen, Ulysses, and Colby soils are included, as well as small acreages of other soils that occur mainly in other parts of the county. The soils of this association occur in an intricate pattern because of the undulating topography and the mixture of materials.

The Anselmo soils are deep, rather dark, and moderately sandy. Their surface layer is either moderately

sandy or very sandy. The subsoil is a brownish fine sandy loam.

The surface layer of the Keith soils is silty or moderately sandy. The brownish subsoil is deep, dark, and silty. Limy, light-colored, floury loess is present at a depth between 2 and 6 feet.

The soils in this association are fairly well suited to crops. They absorb water rapidly and have a fairly high water-holding capacity. Their natural fertility is high, but these soils have been used mainly for soil-depleting row crops. Wind erosion has greatly reduced the supply of organic matter in the surface layer. Shortage of nitrogen, available phosphorus, and available zinc affects crop growth and yield.

The main problems in farming on soils of this association are controlling wind erosion and bringing about a balance between soil moisture and soil fertility. A cropping system using corn, grain sorghum, wheat, barley, rye, sudangrass, and vetch is suitable if stubble mulching or strip cropping is used to control erosion. The stubble provides organic matter and plant nutrients, in addition to controlling erosion. Under irrigation the main problems are controlling water erosion on the more

sloping soils, maintaining high fertility by rotating crops, and using commercial fertilizer. The time water is applied and amount of water applied are also important in irrigation.

The soils of this association are used chiefly for cultivated crops. Cash cropping, or a combination of cash cropping with raising of livestock, is favored by the farmers. Corn is the main cash crop, but wheat, grain sorghum, rye, winter barley, alfalfa, and forage sorghum are also grown, either for cash or to feed to livestock. Some of the farms of this association include steep, silty soils and very sandy soils that are used for grazing cattle.

The farms are mostly owner operated; about one-third of them are tenant operated. The average farm is about 700 acres, though the range is from 160 to 4,000 acres.

This association is more thickly settled than the Valen-tine and the Elsmere-Dunday associations. Several fairly good roads serve the rural population. In most places good-quality well water is available for irrigation and domestic use.

4. Colby soil association: Silty soils of loess hills and canyons

The soils of this association formed in silty, calcareous, loessal material around drainageways that lead to the Republican River. The areas are generally steep, as the surrounding loessal tableland is irregularly broken by hills that have smooth, rounded tops and rough, broken slopes (fig. 4). This association occurs on the north side of the Republican River in the eastern part of the county. South of the Republican River it stretches across the southern part of the county. About 60,000 acres is in this association.

Colby soils and Rough broken land, loess, are dominant in this association. Some of the acreage consists of Ulysses and Keith soils and of Broken alluvial land, and there are small areas of other soils that occur mainly in other parts of the county.

The Colby soils are deep and silty and have only a thin, slightly darkened surface layer. Their texture is loam, and they have an abundance of lime. They make up about 53 percent of this association.

Rough broken land, loess, makes up about 25 percent of this association. It occurs on rough, "catstep" slopes and lies over the same materials as the Colby soils. Caliche or shale crops out on the lower part of some slopes. This steep land has an even thinner surface layer than the Colby soils. Actually, it has little true soil.

Among the minor soils of this association are the Keith and Ulysses, which are on smoother and less steep slopes than the Colby. They are developing in the same materials as the Colby soils, but they have darker and thicker upper soil layers. The Ulysses soils, including those overlying shale, total about 14 percent of the association; and the Keith soils, about 1 percent. The Ulysses soils underlain by shale (Ulysses, clay substratum variant) make up about 4 percent of this association.

Broken alluvial land—silty wash and fill materials from the surrounding steep hills and canyons—is in the low, narrow valleys along drainageways in the main canyons. This land type occupies about 3 percent of the association.

The soils of this association are too thin and steep for cultivation but are well suited to grasses. They are moderately porous and absorb moisture readily, but the steep slopes cause runoff during the short, intense, summer thunderstorms. Moisture seldom soaks down to any great depth. Western wheatgrass, little bluestem, side-oats grama, blue grama, and other mid and short grasses are best adapted to the soils of this association.

Conserving moisture and controlling erosion are the main problems in managing this soil association. Some farmers and ranchers have the problem of locating wells where there is water of good quality.

The soils of this association are used mainly for grazing. Some ranchers and farmers, who have acreages on the loessal upland plains of association 5 or the river valleys of association 6, grow wheat or general crops. On this association, farmers favor either livestock production or a combination of cash cropping and livestock raising. Wheat is the main cash crop. Sorghum and some alfalfa are grown as feed for livestock. About two-thirds of the farms or ranches are operated by owners, and about one-third by tenants. The average unit is 900 acres, but the range is from 300 to 3,000 acres.

Several dirt roads are near this association; they follow the nearly level tableland above it, or are on the lowland near the streams. Few roads pass through this association, but most of the pastures can be reached by trails.

5. Keith soil association: Silty soils of loess upland plains

This association is on a high, broad, nearly level tableland that in places has been modified by small, shallow depressions, locally known as buffalo wallows, or lagoons (fig. 5). Most of the surplus moisture either collects in these small depressions or follows the swales and eventually reaches the drainageways of the Colby association. About 67,000 acres is in this association.

The Keith soils make up about 94 percent of the association; the Goshen, about 4 percent; and the Scott, about 1 percent. About 1 percent consists of Ulysses, Colby, and other soils.

The Keith soils are deep and silty. They have a thick, dark, silt loam surface layer and a brownish silt loam or silty clay loam subsoil that breaks naturally into fine and medium-sized blocks. Almost everywhere the lime-filled, light-colored, silty parent loess is at a depth between 3 and 5 feet.

The Goshen soils occur in the well-drained swales where they receive some additional moisture and soil material from surrounding soils. They have a thick, dark, silt loam surface soil and a rather dark, silt loam or silty clay loam subsoil. Light-colored, lime-filled, silty loess is at a depth between 4 and 6 feet.

The Scott soils occupy the undrained, shallow depressions where water stands for different lengths of time at different seasons. These soils are deep and very dark. They have a thin silt loam surface soil that is underlain by a thick, black, fine-textured, sticky clay subsoil. Lime is leached out to a depth of 6 feet or more.

All the soils of this association are fertile and productive. They contain a large amount of organic matter. They are rather porous and absorb water easily; they

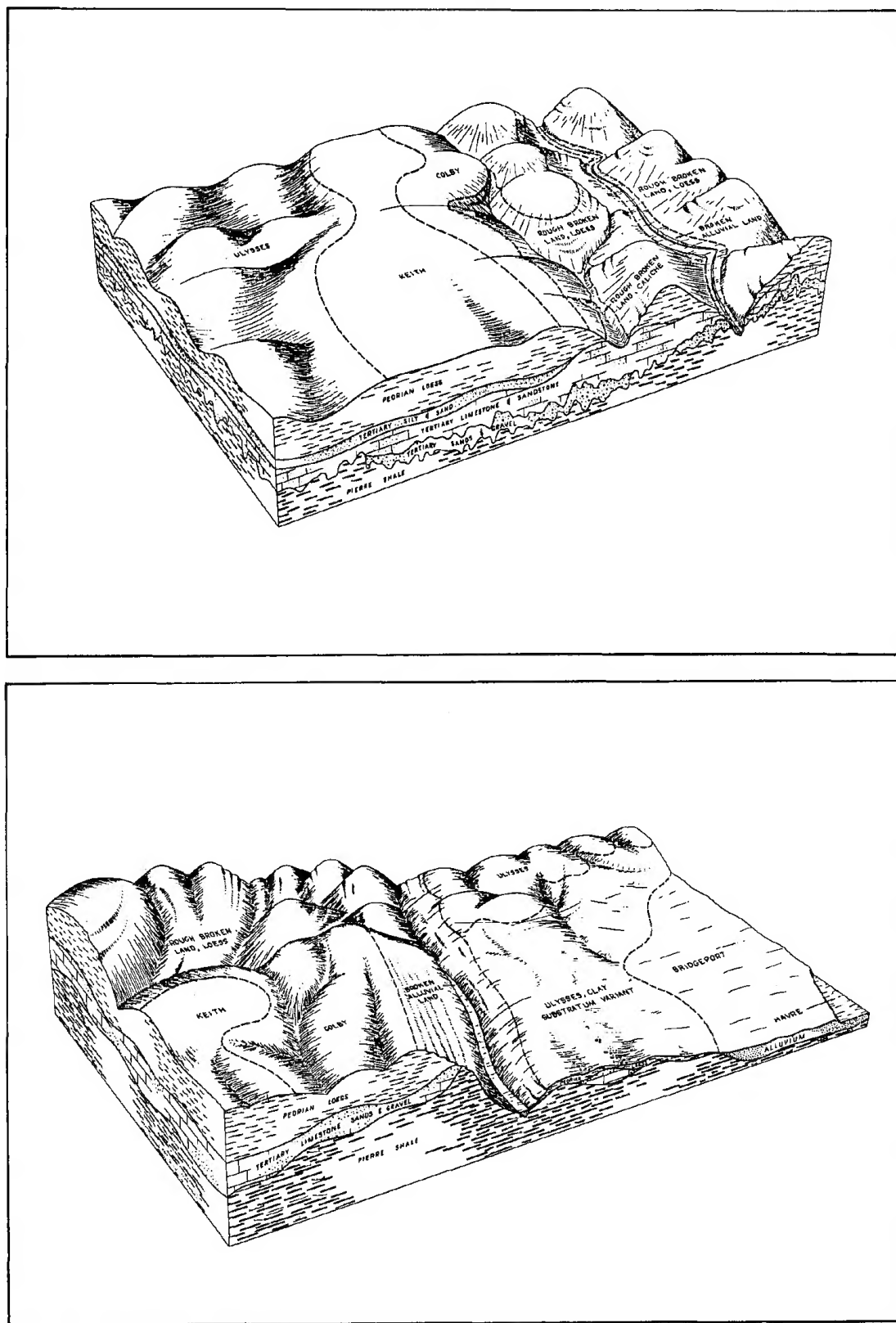


Figure 4.—Colby soil association: *Top*, typical area in the Colby soil association; *bottom*, Colby soil association merging with the Bridgeport-Havre soil association.

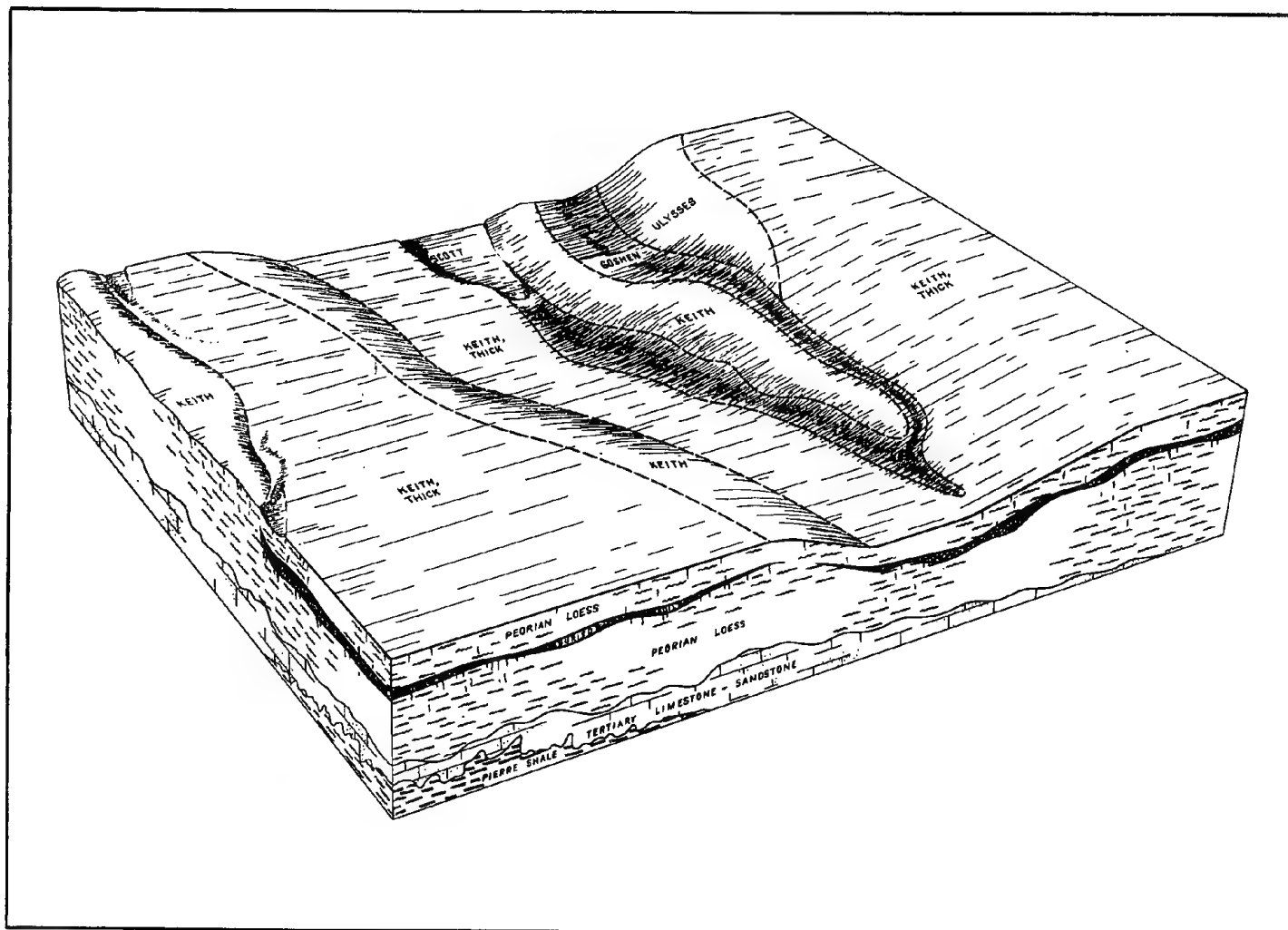


Figure 5.—Typical area in the Keith soil association.

have a high capacity for storing moisture; and they readily release water and nutrients to plants.

On this soil association the main problems are getting a balance between supply of moisture and plant nutrients. If the more sloping and eroded soils are terraced, stubble mulched, and fertilized, erosion can be controlled and fertility maintained. Where a large amount of wheat stubble is left, a light application of fertilizer may help to get corn or grain sorghum off to a good start. On the uneroded soils that are fallowed in summer and have a good supply of moisture, fertilizer causes a rank growth of grain that lodges badly.

This soil association is used mainly to grow cash-grain crops. Wheat is the principal cash crop, but grain sorghum and corn are also grown. On the farms that produce livestock, some sorghum is grown for feed.

About two-thirds of the farms on this association are operated by owners. The farms average about 300 acres, but the range is from 160 to about 1,000 acres. Many of the farm homes are modern. Deep wells are generally located to provide water for domestic use. This association is one of the most thickly populated in the county. Several dirt roads pass through it.

6. Bridgeport-Havre soil association: Loamy soils of valley-fill foot slopes and high bottom lands

This association occurs at the base of upland slopes and on high bottom lands along the Republican River and its tributaries (fig. 6). It covers about 18,000 acres. The soils are well drained and nearly level to gently sloping. Only small acreages have steeper slopes.

The Bridgeport soils occur along tributaries of the Republican River and at the base of upland slopes. They are on materials recently washed or worked down from steeper slopes, mainly from soils of the Colby association. The Bridgeport soils are deep, medium in texture, and uniform to a depth of 5 or 6 feet. They are rather light-colored loams that contain free lime carbonate. They are the most extensive soils of the association.

The Havre soils, on materials carried in by the Republican River, are the most extensive soils of the high bottom lands. They are fairly deep, as the river sediments of coarser sandy material are 2½ to 5 feet below the surface. Although they are layered with different kinds of river sediments, their subsoil is medium, or loamy, in texture. Havre soils, like the Bridgeport soils, are rather

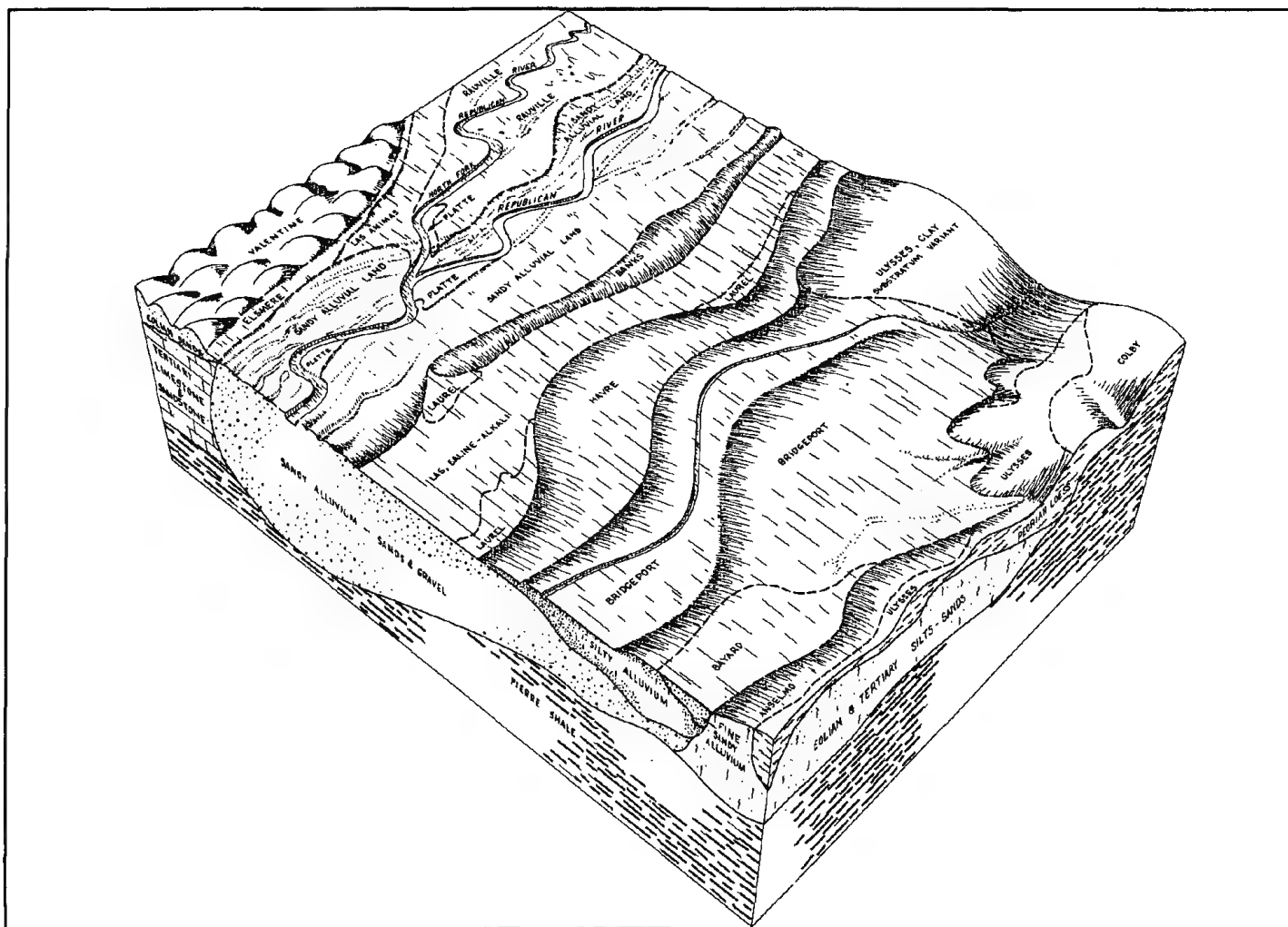


Figure 6.—The Bridgeport-Havre soil association, on the right, merges with the Sandy alluvial land-Las association.

light colored and contain an excess of free lime carbonate.

Bayard, Glendive, and other soils occupy only a minor part of the association.

Most of the soils in this association are well suited to cultivation. They are rather porous, absorb water readily, and have a high water-holding capacity. The special problems are fertility of all the soils and wind erosion on the more sandy soils. Since most of the soils have little organic matter and an excess of lime, many of them lack nitrogen, available phosphorus, and available trace elements, particularly zinc and iron. Use of fertilizers and choice of crops help to overcome these problems. The use of stubble crops and stubble-mulch farming or strip-cropping helps prevent soil blowing and maintains or increases fertility and the content of organic matter.

Most of the association is used for general farming that combines cash crops and livestock. Wheat is the main cash crop, but corn, alfalfa, and small amounts of grain sorghum, forage sorghum, and sugar beets are also grown, either for cash or for feed. Many of the farms include pasture or farmland on the adjacent uplands or on the Sandy alluvial land-Las soil association.

The average farm holding in this association is about 500 acres. Many farms, however, are about 160 acres, and a few are about 1,500 acres. Several farms are irrigated with water from wells or ditches. In most places underground water is sufficient for domestic use, but it is difficult to locate enough, in every place, for pump irrigation. When it is found, it is not always of the best quality, as it contains various amounts of salts.

7. Sandy alluvial land-Las soil association: Sandy and loamy soils of river lowlands

The soils in this association are on the low flood plains of the Republican River and its larger tributaries. They are nearly level to very gently sloping and subject to overflow. Floodwaters have made the topography slightly undulating. The water table is 1 to 8 feet below the surface.

This soil association is made up of the following: Sandy alluvial land, 30 percent; Las, saline-alkali, 20 percent; Rauville, 13 percent; Banks, 7 percent; Platte, 6 percent; Laurel, 4 percent; Las Animas, 4 percent; Elsmere, 1 percent; and river and river channels, 15 percent.

Most of these soils are not well suited to cultivation, as they are sandy, have a high water table, or are affected by salts or alkali. All the soils except those that are very sandy contain free lime carbonate. Most of the soils are shallow over coarse sand. Prairie grasses grow well because the soils are porous and the water table is near the surface. The limited acreage suited to cultivation requires careful management, including choice of suitable crops and addition of soil amendments.

Most of the soils are used for pasture or meadow. Ranching or the cash crop-livestock farming used on the soils of the Bridgeport-Havre soil association is practiced. Alfalfa is the main crop where the soils are cultivated.

Use and Management of Soils

This section has several main parts. The first is provided for those interested mainly in managing soils for production of cultivated crops, either dry farmed or irrigated. Here, basic practices of management are presented, the system of capability grouping is explained, and management is suggested for capability units, which are groups of soils that need similar management and that respond in about the same way.

The second part provides yields at two levels of management, that practiced in the county at the time the survey was made and an improved level of management that most farmers or ranchers will find practical.

The third part concerns management of rangeland. The system of appraising native range is explained, the soils are grouped by range sites, and some suggestions on management of each site are given.

The fourth part mentions the location of the few wooded areas in the county and provides guidance for those who wish to plant windbreaks in fields or around farmsteads. The fifth part, a minor one, gives some suggestions on management of those areas to be used as habitats for wildlife. The sixth, on soils engineering, provides tables concerning those characteristics of the soils that are significant when they are used for roads, dams, and other structures.

Basic Management Practices

Dundy County is in the heart of a semiarid region. The climate is subject to erratic hailstorms, dashing rainstorms, droughts, hot winds, and wide variations in temperature.

Early settlers brought with them the agricultural practices they had learned in the East, but these were not appropriate in a land of recurring drought and wind. The native grass, promising before grazing, did not grow back in a few weeks as in the higher rainfall areas to the east. The land broken for cultivation would produce a crop if it rained, but, too often, rain did not come. Their plowed land was eroded by wind and water.

Through the years, however, the farmers in this area have learned basic practices of agriculture that help offset the major problems, which are conservation of moisture and control of wind erosion.

Conserving moisture

To conserve moisture, rain and snow must be held so that water soaks into the soil. There are several methods of doing this, and the result is best when some combination of the following methods is applied:

1. Use a cropping system that allows the soil to store moisture, and plant crops that use water efficiently and therefore resist drought.
2. Keep crop residue or a plant cover on the soils so that they will not seal, or crust over, under the impact of raindrops.
3. Farm on the contour, stripcrop, and use terraces to prevent concentrations of water that will cause erosion; in short, slow the water so that it will soak into the soil (fig. 7).



Figure 7.—Stripcrops and terraces hold snow on the land.

4. Leave tall-standing stubble in fields to catch snow.
5. Plant sudangrass, or similar crop, thickly in narrow strips, or use trees and shrubs as field windbreaks, to catch snow and check soil blowing.
6. Till the soils when they are not so wet that they will clod or pack, and till at various depths to control formation of a plowpan.
7. Control weeds, which take moisture from the soil that otherwise would be stored for the crop.
8. Leave crop stubble at the surface and return crop residue to the soil; thus, you provide a mulch that slows evaporation of moisture and checks the drying effect of strong winds.

The value of the foregoing practices in conserving moisture is perhaps more obvious than the value of their side benefits. Nevertheless, studies show that 75 percent of the damage caused by runoff and floods occurs in rural areas where rains fall on farms and rangeland. The farmer loses water that plants need, loses topsoil in which crops make their best growth, and may lose crops through

washing out or silting. Further, reservoirs and streams are silted, railroads and roads are washed, fences are damaged, small bridges are washed out, and ditches or gullies are made (fig. 8).



Figure 8.—Road damaged by erosion.

Controlling wind erosion

The practices that conserve moisture, in large part, also help to control wind erosion. In this county, however, there are dry periods during which crops do not make sufficient growth to protect the soils. If management in the year or years previous has not been appropriate, the soils will blow (fig. 9). Among the practices of management commonly used to control this blowing are stubble-mulch tillage, stripcropping, and emergency tillage.



Figure 9.—Tons of soil blown into a fence row from adjoining fields.

Stubble-mulch tillage.—This is a practice used on fields planted to row crops, small grains, or a combination of the two. The success of the practice depends on production of crops that provide sufficient stubble, the use of tillage machinery that will work this stubble only part way into the surface layer, and drilling the new crop through the surface mulch into the mineral soil.

The objective is to have enough stubble at the surface to protect the soil until the next crop has been planted and has grown high enough to provide resistance to the wind. The very sandy soils, such as the Dunday, Anselmo, and Bayard loamy fine sands, need about 1,750 pounds of stubble residue at the surface when the next crop is planted; moderately sandy soils, such as the Anselmo, Keith, and Havre fine sandy loams, need about 1,250 pounds; and silty soils, such as Keith silt loam, about 750 pounds.

Help in estimating the amount of stubble on a field can be obtained from a local representative of the Soil Conservation Service. Then, the effect of tillage needs to be taken into account. A one-way disk will cover about half the residue in one time over the field, whereas a machine equipped with sweeps or blades spaced 32 inches apart will cover about 10 percent in one time over the field. Judging correctly the amount of stubble needed at the surface is probably more critical than the type of machinery used (fig. 10). Planters or special deep-furrow seeders with hoe-type drills are used to seed crops in stubble mulch.

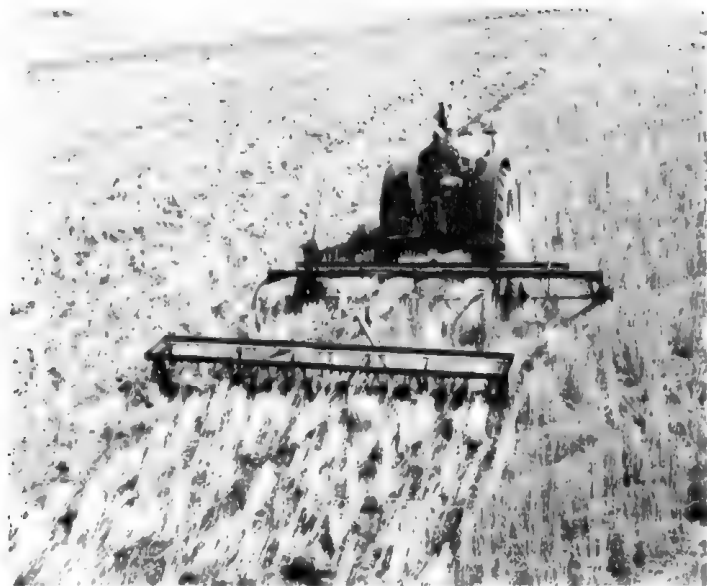


Figure 10.—Rod weeder equipped with special shovels is followed by a cutter-packer; a good stubble mulch is formed the first time over the field.

Emergency tillage.—In dry years, cultivated crops may not produce enough growth to furnish the amount of cover needed to protect the soil. When this happens, emergency tillage—roughening of the surface to resist blowing—is a useful practice (fig. 11).

Stripcropping.—Planting of crops of different heights and kinds in alternating strips is a useful way of cutting down the speed of the wind. The wind does not get hold



Figure 11.—This field was listed to leave clods at the surface. The sandy soil contains few clods, however, and needs a protective plant cover.

of the topsoil in one large sweeping action, as it does in an open field. Stripcropping used with stubble mulching or similar control is more effective than when used alone. Width of strips depends on the kind of soil. Widths range from 3 rods for very sandy soils, such as Dunday loamy fine sand, to 20 rods for medium-textured soils, such as Keith silt loam.

Applying fertilizer

Good management of nonirrigated cropland requires use of commercial fertilizer. If plants are to produce high yields and residue enough to provide protection from wind and water, they need plant nutrients. Fertilizer is not a cure-all for soil problems, but if properly used, it supplements other conservation practices.

Use fertilizer according to the results of soil tests and with consideration of the supply of moisture. Soil tests are made by the Nebraska Soil Testing Service, Nebraska College of Agriculture, at Lincoln. This service can be obtained through the county agent.

The balance between soil moisture and fertilizer is critical under dryland farming. This is especially true of nitrogen fertilizer. Nitrogen needs to be applied according to the amount of moisture in the soil at the time of application. If too much nitrogen is applied early in spring, there is early rapid growth that depletes the moisture supply to the place where it will not support the large plants produced. Consequently, yields are greatly lowered.

Generally, the soils of the county that are cropped continuously, as well as the eroded soils, are low or very low in nitrogen. If a heavy stubble has been left on the field, row crops especially need starter fertilizer, as nitrogen is required to decompose the residue left from the previous crop and to encourage growth of the crop just seeded. A plant receiving sufficient nitrogen has dark green foliage. Lack of nitrogen is evidenced by a gen-

eral pale-green color, stunted growth, and, in the instance of corn, yellowing of the midrib of the lower leaves.

The need for phosphorus fertilizer is not so critical on dryland as need for nitrogen. Nevertheless, phosphorus should be in balance with nitrogen. Phosphorus must be worked into the ground. This can be done before planting, or when the small grains are drilled. Available phosphorus is generally low in all the soils that have an excess of lime, such as the Bridgeport, Havre, and Bayard soils; in the eroded soils; and in the sandy soils of the Anselmo, Banks, Dunday, Keith, and Vebar series.

Most soils of this county contain much potassium, but potassium fertilizer may be needed on the sandy soils that are cropped.

Minor elements deficient in the soils of this county are zinc and iron. A deficiency of zinc is evidenced by yellowing between the veins of the plant leaf. The symptoms are most noticeable on corn or garden crops. Shortage of available zinc is more likely to occur in the limy soils and the sandy soils. High cost limits use of zinc under dryland production of field crops.

A low supply of available iron is normally evidenced by yellowing of plant leaves. It shows particularly on field sorghum, garden crops, lawns, and fruit trees. The limy soils usually do not have sufficient available iron for good plant growth.

Selecting suitable crops

Selection of crops with consideration of the soils is an essential part of good management. For the stable soils suitable for cultivation, wheat and other small grains, sorghum, and grasses are best under continuous dryland farming. Corn and alfalfa are grown, but there is barely enough rainfall.

If corn is grown, it is a less desirable crop than wheat or sorghum on the hardlands, or silty soils. It does better on the moderately sandy soils because they have better moisture-fertility relationships. Nevertheless, wheat or other small grains and sorghum are just as well suited to these sandy soils as corn.

Growing of wheat or other small grains on the sandy soils does not necessarily cause soil blowing. Soil management, rather than the crop, is to blame for most of the blowing. If clean cultivation is used without stripcropping, stubble mulching, and a suitable cropping sequence, sandy land planted to wheat will blow. Usually all or some part of the crop is lost every year.

The blowing and crop damage in a wheatfield is easily noticed. Actually, the blowing is just as severe in a cornfield, but it comes when it likely will not be noticed. Corn has less fibrous roots than wheat. Under clean cultivation, it breaks down soil structure, depletes the supply of humus, and contributes more to instability of the soil than wheat. Land planted to corn will blow in fall, winter, or spring. The blowing is not noticed because the matured crop has been harvested. The damage is to the soil, not to the crop. Soils planted continuously to corn show the real extent of their deficiency in plant nutrients when they are irrigated.

Moderately sandy soils recently broken from sod and planted to wheat will not blow because they have ample organic matter and good structure. To keep these soils from blowing, it is necessary to maintain their supply of organic matter, their cloddiness, and their fertility.

If the cropping system is fallow-wheat, or fallow-wheat-sorghum, or fallow-wheat-corn, stubble mulching and stripcropping will be needed. If corn is planted continuously on the moderately sandy soils, vetch, or vetch and rye, should be interplanted with the corn (fig. 12), or



Figure 12.—Corn in rows 80 inches apart and interplanted with rye and vetch.

cover crops should be used. Generally, sorghum is better than corn because the sorghum stubble provides more protection near the ground.

The silty soils of the uplands are not suitable for alfalfa, and the well-drained, moderately sandy soils of the uplands are only fair for this crop. In a few years, alfalfa draws out nearly all the soil moisture. Further, when the crop is cut, little residue is left at the surface. Erosion is thus encouraged, and care is needed to keep the soil from blowing when it is prepared for cultivation.

Alfalfa can do little to enrich a soil if the soil blows. Grasses or other close-growing crops, in contrast, have fibrous roots that hold the soil together and provide residues that help check blowing. A small amount of grass mixture seeded with alfalfa often will help a soil to resist the wind. The grasses increase as the alfalfa ages and thins.

Irrigating

More and more land in Dundey County is being put under pump irrigation. Irrigation requires planning and ingenuity. First, there must be enough acreage of soils suitable for irrigation; second, enough water of good quality; and third, a system for delivering the water that is appropriate for the kind of soil and lay of the land.

When water is applied to dry land, a new, complex system of management is required. The operator must learn how to apply water, when to apply it, and how to distribute it evenly. Deficiency in plant nutrients not obvious in dryland farming becomes apparent under irrigation. The operator, therefore, needs to make adjust-

ments in his methods of maintaining soil fertility. Planting rates need to be changed because irrigated land will support a greater plant population. Also, the operator will have to take into account the need for a crop rotation that includes legumes and green-manure crops, partly as a means of increasing fertility and partly as a way of maintaining structure, which tends to change under irrigation.

The amount of water available needs to be judged in relation to the kinds of crops and the labor required to grow them. For example, low-producing wells may be utilized better by off-season irrigation. The advantage of irrigating these crops late in fall and early in spring should be considered.

Irrigation is costly, and cropping systems and the use of fertilizer may have to be drastically altered to make irrigation pay its way. Help in planning an irrigation system can be obtained from local technicians of the Soil Conservation Service, from the county agent, or from specialists of the College of Agriculture, University of Nebraska.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, II_e. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils are subject to little or no erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient group-

ing for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations. Not considered is major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil, nor possible but unlikely major reclamation projects.

In this report, soils are first classified according to their capability when used without irrigation, and then according to their capability when irrigated.

Dryland capability groupings

All the soils of Dundy County have been placed in classes, subclasses, and capability units as shown in the list that follows. Some of the soils in this list are not suitable for cultivation under dryfarming methods. Soils of classes I through IV are in varying degrees suitable for cultivation, as explained in the discussion of each capability unit and in the introduction to this section. Soils of classes V, VI, VII, and VIII are not suitable for cultivation.

Class I.—Soils that have few limitations that restrict their use. No soil in Dundy County is in this class unless irrigated.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe.—Soils subject to moderate erosion if they are not protected.

Unit IIe-1.—Very gently sloping, silty or loamy soils.

Unit IIe-3.—Nearly level to very gently sloping, moderately sandy soils.

Subclass IIc.—Soils limited mainly by climate—limited rainfall.

Unit IIc-1.—Nearly level, silty or loamy soils.

Class III.—Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe.—Soils subject to a high risk of erosion when tilled.

Unit IIIe-1.—Gently sloping, silty or loamy soils.

Unit IIIe-3.—Gently sloping, moderately sandy soils.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, or require very careful management, or both.

Subclass IVe.—Soils very severely limited by risk of erosion if cover is not maintained.

Unit IVe-1.—Sloping, loamy soils.

Unit IVe-3.—Nearly level to sloping, moderately sandy soils.

Unit IVe-5.—Nearly level to very gently sloping, very sandy soils.

Subclass IVw.—Soils very severely limited for cultivation because of excess water.

Unit IVw-5.—Nearly level, moderately sandy to very sandy soils with a moderately high water table.

Unit IVw-6.—Nearly level, moderately sandy soils with a moderately high water table.

Subclass IVs.—Soils very severely limited, mainly by salinity and alkali.

Unit IVs-1.—Nearly level, saline and alkali soils.

Class V.—Soils that have little or no susceptibility to erosion but that have other limitations impractical to remove that limit their use mainly to pasture, range, woodland, or wildlife food and cover.

Subclass Vw.—Soils very severely affected by excess water.

Unit Vw-1.—Soils that have a high water table or are frequently flooded.

Class VI.—Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use mainly to pasture or range, woodland, or wildlife food and cover.

Subclass VIe.—Soils severely limited for cultivation, and moderately limited for pasture or trees, because of risk of erosion.

Unit VIe-1.—Silty, moderately steep and steep soils.

Unit VIe-3.—Moderately steep, moderately sandy soils.

Unit VIe-5.—Very gently sloping to hummocky, very sandy soils.

Subclass VIw.—Soils generally unsuited to cultivation because they are very severely affected by excess water.

Unit VIw-1.—Clayey to silty soils or land types that are inaccessible or are frequently flooded.

Unit VIw-5.—Gently sloping to sloping, moderately sandy to very sandy soils with moderately high water table.

Subclass VIs.—Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, salinity, alkalinity, or depth.

Unit VIs-1.—Nearly level soils strongly affected by salts or alkali.

Unit VIs-4.—Nearly level to moderately steep soils that are shallow to bedrock.

Class VII.—Soils that have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, woodland, or wildlife food and cover.

Subclass VIIe.—Soils severely limited by risk of erosion if cover is not maintained.

Unit VIIe-1.—Steep, silty soils or land types in canyon and bluff areas.

Unit VIIe-5.—Thin, very sandy soils or soils on hilly or choppy slopes.

Subclass VIIs.—Soils severely limited by low moisture-holding capacity, shallowness, or other soil features.

Unit VIIs-3.—Very shallow soils or land types.

Class VIII.—Soils and landforms that have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife habitats, water supply, or esthetic purposes. No soil mapped in Dundy County is in this class.

CAPABILITY UNIT IIc-1, DRYLAND

The soils of this unit are deep, silty or loamy, and very gently sloping. They are on uplands or are at the base of slopes that border the lowlands. The soils are—

Bridgeport loam, 1 to 3 percent slopes.

Keith silt loam, 1 to 3 percent slopes.

Keith silt loam, thick, 1 to 3 percent slopes.

Wheat, sorghum, barley, corn, and rye are suitable crops. Corn is least suitable on the Keith soils but can be grown when the supply of moisture is favorable. Sorghum tends to yellow on the Bridgeport soil because it cannot obtain enough iron. Alfalfa is fairly well suited to the Bridgeport soil.

The soils of this unit are among the best for agriculture, though runoff and erosion are slight hazards. Terracing, contour farming, stripcropping, contour stripcropping, and stubble-mulch tillage are good farming methods. They help in controlling erosion, conserving moisture, and attaining better balance between soil moisture and fertility.

A cropping sequence that provides 1 year each of stubble-mulch fallow, wheat, and grain sorghum is promising for the Keith soils. On the Bridgeport soil, a good sequence is 1 year each of stubble-mulch fallow, wheat, and corn. Alternate wheat and stubble-mulch fallow is a good sequence for all soils of this unit.

Most crops on the Bridgeport soil respond to nitrogen and phosphorus; corn on this soil may show symptoms indicating a shortage of zinc. In dryland farming, however, use of zinc is limited by its cost. The thin and eroded spots in the Keith soils respond when nitrogen and phosphorus are applied. If too much nitrogen is applied to Keith silt loam, thick, 1 to 3 percent slopes, small grains make rank growth and lodge in wet years, and all crops may burn in dry years.

CAPABILITY UNIT IIc-3, DRYLAND

In this unit are deep, nearly level to very gently sloping, moderately sandy soils on uplands, on foot slopes, or in well-drained lowlands. The soils are—

Anselmo fine sandy loam, 0 to 1 percent slopes.

Bayard fine sandy loam, 0 to 1 percent slopes.

Glendive fine sandy loam.

Goshen fine sandy loam, 0 to 1 percent slopes.

Havre fine sandy loam.

Keith fine sandy loam, 1 to 3 percent slopes.

Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes.

Keith fine sandy loam, thick, 0 to 1 percent slopes.

Keith fine sandy loam, thick, 1 to 3 percent slopes.

Wheat, sorghum, barley, rye, corn, sudangrass, vetch, and grass are suitable for these soils. Sorghum is least suited to the Bayard, Havre, and Glendive soils. The crop yellows because it does not obtain enough iron. Corn on these soils shows symptoms indicating that it cannot obtain sufficient zinc, and the same is true on the Anselmo soil. Alfalfa is a fairly suitable crop for the Bayard, Havre, and Glendive soils.

The soils of the unit are good, but blowing is a slight hazard. Continuous cropping to corn is the main practice, but a few farmers use a system of alternate wheat and fallow.

A cropping system made up of wheat, barley, rye, or other close-growing crops and corn or other clean-cultivated row crops is appropriate. Large fields on these

soils should be fallowed only if sufficient stubble is left on or near the surface to control blowing. Fields can be protected by using alternate strips of crops and fallow, each strip 5 to 10 rods wide and running crosswise to the prevailing wind. If these strips prove wider than necessary, narrower ones can be used.

Nitrogen, phosphorus, and zinc are likely to be deficient in all soils of this unit, and especially in the Bayard, Havre, and Glendive soils. Because there has been wide variation in past and current management of these soils, it is desirable to test the soils before applying fertilizer. Farmers can use check strips to learn the response to fertilizer. Care is needed in using fertilizer, particularly nitrogen. The amount of nitrogen needs to be kept in balance with the moisture supply.

CAPABILITY UNIT IIc-1, DRYLAND

The soils in this unit are nearly level, deep to moderately deep, and silty or loamy. They are on uplands and in well-drained lowlands. The soils are—

Bridgeport loam, 0 to 1 percent slopes.

Goshen silt loam, 0 to 1 percent slopes.

Havre loam.

Keith silt loam, caliche substratum, 0 to 1 percent slopes.

Keith silt loam, thick, 0 to 1 percent slopes.

Wheat, sorghum, barley, corn, and rye are suitable crops. Corn is the least suitable crop on the Keith soils but can be grown in years when moisture is favorable. Sorghum is least suitable on the Bridgeport and Havre soils; it yellows because it does not get enough iron. Alfalfa is fairly well suited to the Bridgeport and Havre soils.

These soils are among the best for agriculture. They have a high water-holding capacity and are easily tilled. The principal limitation is shortage of rain. Conserving moisture and maintaining a balance between moisture and fertility are the main problems. Soil blowing is a secondary problem.

A cropping system that includes fallow is best. Tillage of fields after harvest, late in summer or in fall, controls weeds that would deplete the supply of moisture. Stubble or other crop residue adds organic matter and will check wind erosion if left on the surface.

Strips of wheat or other crops alternating with strips of fallow will help to check soil blowing if the strips are 10 to 20 rods wide and run crosswise to the direction of the prevailing wind. A promising cropping sequence for the Keith and Goshen soils is 1 year each of fallow, wheat, and grain sorghum. Suitable for the Bridgeport and Havre soils is 1 year each of fallow, wheat, and corn. Alternate wheat and fallow is a good sequence on all soils of this unit, and one frequently used.

Crops on the Bridgeport and Havre soils respond to nitrogen and phosphorus; corn planted on these soils shows symptoms of zinc deficiency. Because of its high cost, zinc is applied only where the shortage is extreme.

Fields need to be checked for amount and depth of soil moisture before fertilizer is applied. If too much nitrogen is applied to the Keith and Goshen soils, small grains grow tall and lodge badly in wet years, and all crops burn in dry years. Starter fertilizer may be needed if corn or sorghum is to be planted in fields where a large amount of residue has been left from the preceding crop.

CAPABILITY UNIT IIIe-1, DRYLAND

This unit consists of deep, gently sloping, silty or loamy soils on uplands and foot slopes. The soils are—

Bridgeport loam, 3 to 5 percent slopes.

Keith silt loam, 3 to 5 percent slopes, eroded.

Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded.

Wheat, sorghum, barley, rye, sudangrass, corn, and grass are suitable for these soils. Corn is least suitable but can be grown in years when moisture is favorable. The soils will wash if corn, sorghum, or some other clean-cultivated crop is planted up and down the slope. Of the crops grown, corn is the crop most likely to show symptoms of nutritional deficiency.

These soils are among the best in the county, but water erosion is a problem, and at times wind erosion is a hazard. Terracing, contour farming, and stubble-mulch tillage are methods of controlling erosion and conserving moisture. A good cropping system is one that keeps the soils under wheat, barley, rye, or a similar close-growing crop most of the time.

Alternate wheat and fallow is the cropping system now most used, and this is good if stubble-mulch tillage is practiced during the fallow period, and if water erosion is checked by other practices. Some farmers use a cropping sequence that includes sorghum or corn with the close-growing crops.

Crops respond to nitrogen fertilizer, and phosphorus may also be needed. Best results are obtained if there is a good supply of moisture when nitrogen is applied.

CAPABILITY UNIT IIIe-3, DRYLAND

In this unit are deep, moderately sandy soils and deep soils that have a moderately sandy surface layer over a silty subsoil. These soils are gently sloping and occur on uplands and foot slopes. The soils are—

Anselmo fine sandy loam, 1 to 3 percent slopes.

Anselmo fine sandy loam, 3 to 5 percent slopes.

Anselmo loamy fine sand, 0 to 3 percent slopes.

Anselmo loamy fine sand, 3 to 5 percent slopes.

Bayard fine sandy loam, 1 to 3 percent slopes.

Bayard loamy fine sand, wind-hummocky.

Keith fine sandy loam, 3 to 5 percent slopes, eroded.

Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes.

Wheat, barley, sorghum, corn, rye, sudangrass, alfalfa, and vetch are suitable crops. Alfalfa is the least suitable of these, but it can be grown during years of favorable moisture.

These are good soils. They are easily tilled but are sandy. On exposed slopes soil blowing is always a hazard when they are dry farmed. The more sloping areas are also subject to water erosion.

Practices that help to control wind erosion and conserve moisture are stubble-mulch tillage, stripcropping, use of cover crops, and emergency tillage. Where feasible, terraces can be used to check runoff and water erosion in the more sloping areas.

A good cropping system is one that provides at least 1 year of a close-growing crop to 2 years of cultivated crops. A proportion of 2 years of close-growing crops to 4 years of clean-cultivated crops is better.

A sequence of fallow, wheat, and sorghum is a promising system, especially if the soils are stubble tilled during fallow or if the crops are planted in alternate strips. In

this system, corn can be substituted for sorghum, and rye or winter barley for wheat.

If large open fields on these soils are fallowed, they need a thick stubble at or near the surface until planting time. Fall seeding of small grains can be done a little earlier on these soils than on those more stable, so as to get a growth in fall that will provide good winter cover.

Fields can be protected by using alternate strips of crops and fallow, each strip 5 to 10 rods wide and running crosswise to the most damaging winds. After trial, the strips can be narrowed if this seems necessary. Another means of protecting the soils is fall seeding of rye, winter barley, or other cover crop. If crop failure results from insects, drought, hail, or other cause, the soils can be protected by planting millet, sorghum, or sudangrass as a catch crop.

Alternate wheat and fallow is a good system if the fallowed land is stubble tilled or if the wheat is planted in alternate strips with fallow. Corn, rye, and vetch is a good combination, as is corn and vetch. Rye and vetch, or vetch alone, can be planted with the corn. Also, vetch can be planted in alternate narrow strips with corn.

Vetch, an annual legume, provides cover for the soils and adds nitrogen to them. Further, it can be used for hay or pasture. Sudangrass also has advantages. It is an excellent crop for pasture or seed.

It is good practice to seed strips of sudangrass in corn at intervals of 8 rods, and crosswise to the direction of the wind. The strips of sudangrass are 2 to 4 rows wide, and their location is changed from year to year.

The cropping system generally practiced on these soils is continuous corn. A few farmers use wheat, fallow, and corn.

These soils normally are deficient in nitrogen, phosphorus, and zinc. Farmers and ranchers can fertilize trial strips to learn the response. The amount and depth of soil moisture is important in using fertilizer, especially nitrogen. Alfalfa, vetch, and small grains will more likely respond to phosphorus than other crops. Corn, small grains, and sudangrass normally need nitrogen. Corn needs zinc, but under dryfarming, its high cost limits use to places where response of corn has been especially good.

CAPABILITY UNIT IVe-1, DRYLAND

In this capability unit are deep, loamy soils of the uplands. The soils are—

Colby loam, 3 to 9 percent slopes.

Ulysses silt loam, 5 to 9 percent slopes.

Ulysses silt loam, 5 to 9 percent slopes, eroded.

Wheat, rye, and barley are suitable crops. The soils, however, are only fair for cultivation. Water erosion is the main problem, and wind erosion and fertility are secondary. Terracing, contour farming, and stubble-mulch tillage are good practices for controlling erosion, conserving moisture, and increasing the supply of organic matter.

A cropping system consisting entirely of close-growing crops is needed. Alternate wheat and fallow is a good system, and the one commonly followed. Winter barley, rye, close-drilled forage sorghum, or sudangrass can be substituted for wheat in this system.

Small grains respond to nitrogen and phosphorus when there is abundant moisture in the soils.

CAPABILITY UNIT IVc-3, DRYLAND

In this capability unit are moderately deep, slightly sandy, level to sloping soils and deep, moderately sandy, sloping soils of the uplands. The soils are—

Anselmo fine sandy loam, 5 to 9 percent slopes.
Anselmo fine sandy loam, 5 to 9 percent slopes, eroded.
Vébar fine sandy loam, moderately deep, 0 to 3 percent slopes.

Wheat, rye, barley, sorghum, corn, sudangrass, alfalfa-grass mixtures, and vetch are suitable crops.

These soils are only fair for cultivated crops because they are sandy and steep, or because they are sandy and have a moderately deep rooting zone. Wind erosion is a serious hazard at all times; water erosion and fertility are secondary problems.

Practices that improve these soils are terracing and contour farming, where feasible and practical, and strip-cropping and stubble-mulch tilling.

A cropping system that consists entirely of close-growing crops is best. A close-growing grain crop with stubble-tilled alternate fallow is good. Many farmers grow corn continuously, but this is not desirable. Row crops, such as corn or sorghum, can be included in the cropping sequence if they are not grown more than 1 year in succession. Alternate strips of crops and fallow, 5 to 10 rods wide and crosswise to damaging winds, can be used.

Crops respond to nitrogen, phosphorus, and zinc. Better yields of crops and forage are obtained from fertilizer if there is ample available moisture. Check strips can be used to learn response to fertilizer. Using zinc or other fertilizer for corn is normally too costly on these soils if they are dry farmed.

CAPABILITY UNIT IVc-5, DRYLAND

This unit is made up of very sandy, nearly level to very gently sloping soils of the uplands and bottom lands. The soils are—

Banks loamy fine sand.
Dunday loamy fine sand.
Dunday loamy fine sand, loam substratum.

Rye, wheat, corn, sorghum, sudangrass, alfalfa-grass mixtures, and vetch are suitable; the alfalfa-grass combination is best.

These soils are only fair for crops because they are so sandy that soil blowing is a serious hazard under dry-farming. A large acreage was once cultivated, but some areas have been abandoned or have reverted to grass.

Under proper management these soils can be farmed. Stripcropping, stubble-mulch tillage, and suitable cropping systems can be used to control soil blowing and to conserve moisture. Fallowing is to be avoided. It is preferable to sow different crops in alternate strips that are 3 to 7 rods wide and run crosswise to the most damaging winds. Where practical, 12 to 14 inches of stubble can be left in harvesting crops and kept at the surface until the next crop is planted.

A cropping system of corn with rye and vetch, or corn with vetch, is good. The rye and vetch, or the vetch alone, can be planted in narrow alternate strips with corn, or can be planted in the corn. Vetch, an annual winter legume, provides cover and adds nitrogen to the soil. Also, it can be used for hay or pasture.

Crops respond to nitrogen, phosphorus, and zinc. Al-

falfa, vetch, and small grains respond to phosphorus. Small grains and sudangrass may need nitrogen. Corn and sorghum respond to nitrogen and to zinc. The cost of zinc is normally too high for practical use under dry-farming, except in places where the response is unusually good.

CAPABILITY UNIT IVw-5, DRYLAND

The soils in this unit are deep and sandy and, at times, are wet because of a moderately high water table. These soils are in upland valleys or on bottom lands. They are—

Elsmere fine sandy loam, 0 to 1 percent slopes.
Las Animas loamy fine sand.

Alfalfa, seeded alone or with grass, is the most suitable crop. Rye, wheat, sudangrass, and sorghum can be grown when it is necessary to plow out old meadows and to seed alfalfa. Crops other than alfalfa and grass ought not be grown continuously, as these soils tend to be wet, are subject to blowing, and are low in fertility.

In wet years small grains and row crops may be drowned out, and in dry years the organic matter burns up and the soils blow severely. Cropping practices and methods of tillage that will control wind erosion and increase the content of organic matter are needed. If a small proportion of grass is planted with alfalfa, the quality of hay is good and the soils are easier to stabilize.

These soils can be used for commercial production of native grass seed if the grass is planted in rows and cultivated. Much of the acreage is now in native pasture or hay. Where meadow or pasture supports a sparse stand of grasses that produce low-quality forage, the land can be broken up and seeded to grasses that will produce more hay of better quality.

The largest amount of wild hay, of the best quality, is obtained if grass is cut early, or about July 15. If sufficient acreage is available, the largest amount of forage is obtained if half the meadow is cut every other year. The part of the meadow not cut for hay can be pastured in winter and then cut for hay the next year.

Pasture and meadow can be improved by seeding tame grasses and applying phosphorus. Yields of sweetclover increase sharply if phosphorus is applied. Thus, if sweetclover is not wanted in a meadow, the meadow should not receive phosphorus fertilizer. Check strips can be used to learn the response to fertilizer.

CAPABILITY UNIT IVw-6, DRYLAND

In this unit are nearly level, deep, sandy soils that are occasionally wet because of their moderately high water table. The one soil of this unit in Dundy County is—

Ovina fine sandy loam, 0 to 1 percent slopes.

Most of this soil is in native pasture or hay. Alfalfa or mixtures of alfalfa and grass are most suitable. Alfalfa and alfalfa-grass mixtures are especially responsive to phosphorus. Hay yields best if cut about July 15 and if the meadow is rested every other year. Rye, wheat, sudangrass, and sorghum can be grown when it is necessary to plow out an old meadow or pasture and reseed alfalfa and grass. Continuous use for crops other than alfalfa and grass is not suitable because the soil is wet and low in fertility.

This soil can be used for commercial production of native grass seed if the grass is planted and cultivated in rows.

If a small proportion of grass is sown with alfalfa, the grass roots help to stabilize the soil and the quality of the hay is improved.

CAPABILITY UNIT IVs-1, DRYLAND

In this unit are deep to shallow, moderately saline or alkali soils of the lowlands. The soils are—

Las fine sandy loam, saline-alkali.
Las loam, saline-alkali.

Alfalfa, alfalfa-grass mixtures, and barley are the crops grown under dryfarming. Rye, wheat, corn, or sorghum can be grown between alfalfa plantings or on patches of soil less affected by salts or alkali.

These soils require careful management and may require special treatment and fertilizer because they contain moderate amounts of soluble salts or of sodium. Phosphorus is needed for all crops, and especially for alfalfa. Sorghum and corn may need iron, zinc, and nitrogen. Unless there is great response to zinc, cost is normally too high to allow its use under dryfarming.

During wet seasons the water table may be so high as to interfere with tillage of the lower areas. In dry periods the surface layer may blow. If crops other than alfalfa or grass are grown, tillage at the right time, cropping systems that include close-growing crops, and conservation of crop residue are needed.

Under dryfarming it is not practical to apply the large amounts of sulfur or other chemicals needed to offset the effect of the salts or alkali. Where the water table is 3 feet or more below the surface, small applications of sulfur can be tried to see if there is a response. Sulfur works slowly, especially under dryfarming.

In large part, these soils are used for native pasture, which is excellent if managed properly. Small acreages are used for native hay, which in most places is good if it is produced under good management.

CAPABILITY UNIT Vw-1, DRYLAND

This capability unit consists of wet soils in valleys within the uplands or on the bottom lands (fig. 13). The water table is near the surface. The soils are—

Gannet fine sandy loam.
Platte loam.
Rauville loam.

These soils are wet, and it is not practical to drain them for cultivation. They are used for native hay and pasture.

CAPABILITY UNIT VIe-1, DRYLAND

In this capability unit are deep, silty soils and deep to shallow, moderately fine textured soils that are sloping to moderately steep. The surface layer of these soils is thin. The soils are—

Colby loam, 9 to 30 percent slopes.
Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded.

These soils are too steep and too erodible for continuous cultivation. Most of the acreage can be cultivated enough to establish stubble crops, grass, or trees.



Figure 13.—Rauville loam, in foreground, is in capability unit Vw-1, and Elsmere fine sandy loam, 1 to 5 percent slopes, in background, is in capability unit VIw-5.

Range management that maintains a good cover of grass is the best means of controlling runoff, reducing erosion, and conserving moisture, as well as the best way of producing larger quantities of forage for grazing.

Many sites favorable for stock-water dams, grade-control structures, and flood-detention reservoirs occur in areas of these soils. Care is needed in the selection of each site, as the design of each structure is based on its intended use, the size of the drainage area, the characteristics of the soils, the steepness of slope, the vegetative cover, and other factors peculiar to each location.

CAPABILITY UNIT VIe-3, DRYLAND

Soils in this capability unit are moderately sandy and moderately steep to steep. In this county the one soil is—

Anselmo fine sandy loam, 9 to 30 percent slopes.

This soil is too steep and erodible for continuous cultivation. Most of it can be cultivated enough to establish cover crops, grass, or trees.

Stock-water dams, grade-control structures, and diversion ditches can be built on this soil, but care is needed in selecting the site.

CAPABILITY UNIT VIe-5, DRYLAND

The soils in this capability unit are deep, very sandy, and very gently sloping to hummocky. They are—

Banks fine sand.
Blown-out land.
Valentine fine sand, rolling.
Valentine loamy fine sand.

The soils are poorly suited to cultivation. They are sandy and erodible. They can be cultivated enough to establish cover crops, grass, or trees. Under good management, pasture on these soils produces high yields.

Seed adapted grasses in cultivated areas and in pastures where the stand of grass is poor. A good stand of grass is the most effective means of controlling wind erosion and conserving moisture. Soils of this group are

not suitable sites for stock-water dams or similar structures.

CAPABILITY UNIT VIw-1, DRYLAND

In this capability unit are deep, clayey, silty, or very sandy soils and land types that are inaccessible or frequently flooded. In this unit are—

Broken alluvial land.
Sandy alluvial land.
Scott silt loam.

It is not practical to cultivate land of this capability unit. The areas are hard to reach, too narrow, too sandy, or too frequently flooded. Cultivation sufficient to establish cover crops, grass, or trees can be practiced. Under good management, yields of pasture or hay are high.

Water ponds on Scott silt loam and may drown out the grasses, shrubs, or trees. If stubble mulching, terracing, or similar practices are used on the soils adjacent, some of the runoff can be kept off the Scott soil. Many areas of Scott silt loam are ideal for wildlife because they are relatively small and are scattered within large areas of cultivated soils. These small areas provide nesting places, food, and cover for waterfowl and upland game birds.

Small, wooded and brushy areas of Sandy alluvial land not used for grazing or hay are ideal habitats for deer, squirrel, pheasant, and quail.

CAPABILITY UNIT VIw-5, DRYLAND

Soils in this capability unit are deep and sandy and have a moderately high water table. The only soil of this unit mapped in the county is—

Elsmere fine sandy loam, 1 to 5 percent slopes.

This soil is too sandy and, at times, too wet for cultivation. Yields of forage are high under good management. The soil can be cultivated enough to establish cover crops, grass, or trees.

CAPABILITY UNIT VIa-1, DRYLAND

Soils in this group are severely saline or strongly alkaline and are on bottom lands. The only mapping unit is—

Laurel soils.

Laurel soils are too saline or alkaline for cultivation. They can be cultivated enough to establish suitable plants and grasses.

If adapted grasses and legumes are seeded, and other management is good, the yield of pasture or hay is comparatively high.

Seed suitable grasses and legumes in the cultivated areas and in the pastures where the stand of grass is poor. Before seeding, it is best to mulch and condition the cultivated areas with a heavy application of barnyard manure. Any other organic residue, including stubble from the crop grown the preceding year, will serve the same purpose as manure. Use of large amounts of sulfur to decrease the salinity or alkalinity is not suggested, though this can be tried in small areas for experimental purposes.

Grasses suitable for Laurel soils are reed canarygrass, especially in the seepy places, tall wheatgrass, alkali sac-

aton, western wheatgrass, and switchgrass. Alfalfa is the best legume.

Small areas of Laurel soils next to or within cultivated fields can be seeded and left as nesting and feeding places for upland game birds.

CAPABILITY UNIT VIa-4, DRYLAND

In this capability unit are nearly level to moderately steep soils that are shallow to bedrock or gravel. The only soil of this unit in the county is—

Canyon fine sandy loam, 3 to 5 percent slopes.

This soil is too shallow for cultivation but can be tilled enough to establish cover crops, grass, or trees.

Seed adapted grasses in cultivated areas and in pastures where the stand of grass is poor. A good stand of grass is the most effective means of controlling wind erosion and conserving moisture. This soil is not a suitable site for stock-water dams or similar structures.

CAPABILITY UNIT VIIe-1, DRYLAND

In this capability unit are thin soils or land types consisting of deep silty materials in steep canyons or on bluffs. The one land type in the county is—

Rough broken land, loess.

Rough broken land, loess, is of limited value for grass or trees. Most of it cannot be cultivated; it is too steep.

Range management that will maintain a good cover of grass is the only means of controlling runoff, reducing erosion, and conserving moisture. This management also produces the most forage for grazing.

Many sites suitable for stock-water dams, grade-control structures, and flood-detention reservoirs occur in the areas of Rough broken land, loess.

CAPABILITY UNIT VIIe-5, DRYLAND

In this capability unit are deep, thin, very sandy soils on hilly or choppy slopes in the uplands. The one soil in the county is—

Valentine fine sand, hilly.

This soil is suited to limited use for grass or trees. Under good management pastures produce high yields.

A good stand of grass is the only effective means of controlling wind erosion. This soil is not suitable for stock-water dams or similar structures.

CAPABILITY UNIT VIIa-3, DRYLAND.

In this capability unit are dry, very shallow soils or shallow land types that overlie bedrock or gravel. The one land type in this county is—

Rough broken land, caliche.

This land is of limited use for grass. Most of it cannot be cultivated; it is too rocky and steep.

Control grazing and use other range management to maintain a good cover of grass. A good stand of grass in the cracks and crevices of the rock exposures, and growing close around them, is the only effective means of controlling runoff and conserving moisture. Stock-water dams, grade-control structures, and flood-detention reservoirs can be built, but care is needed in selecting the site and in designing and building the structure.

Irrigated capability groupings

Shown in the following list are the soils of Dundy County considered suitable for irrigation. Comparison of this list with the list for dryland capability units will show that some soils move to a higher capability class when water is applied, and that others remain in the same class. For example, there are no class I soils in the dryland classification, but under irrigation, the deep, silty, nearly level soils that were in capability unit IIc-1 are in unit I-1 when cultivated.

Class I.—Soils that have few limitations that restrict their use.

Unit I-1.—Deep, silty, nearly level soils.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe.—Soils subject to moderate erosion if cover is not maintained.

Unit IIe-1.—Very gently sloping, silty soils.

Unit IIe-3.—Nearly level and very gently sloping, moderately sandy soils.

Class III.—Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe.—Soils subject to severe risk of erosion if tilled and not protected.

Unit IIIe-1.—Gently sloping, silty or loamy soils.

Unit IIIe-3.—Gently sloping, moderately sandy soils.

Subclass IIIw.—Wet soils that require artificial drainage if they are tilled.

Unit IIIw-6.—Nearly level, moderately sandy soils that have a moderately high water table.

Subclass IIIs.—Soils severely limited by shallowness, stoniness, droughtiness, or low fertility.

Unit IIIs-1.—Moderately saline or alkali soils.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, or require very careful management, or both.

Subclass IVe.—Soils very severely limited by risk of erosion if cover is not maintained.

Unit IVe-1.—Sloping, silty soils.

Unit IVe-3.—Sloping, moderately sandy soils.

Unit IVe-5.—Nearly level to very gently sloping, very sandy soils.

Subclass IVw.—Soils very severely limited for cultivation because of excess water.

Unit IVw-5.—Nearly level, moderately sandy and very sandy soils with moderately high water table.

Soils that would be in classes V, VI, VII, or VIII when irrigated are not shown in the foregoing list. Irrigation of the soils in these classes is not considered feasible.

CAPABILITY UNIT I-1, IRRIGATED

The soils in this unit are deep, well drained, silty, and nearly level. They occur on uplands and in lowlands. They are—

Bridgeport loam, 0 to 1 percent slopes.

Goshen silt loam, 0 to 1 percent slopes.

Havre loam.



Figure 14.—Irrigated tame grass pasture on Bridgeport loam, 0 to 1 percent slopes, provides much forage early and late in the season and adds roots, organic matter, and nutrients to the soil.

Keith silt loam, caliche substratum, 0 to 1 percent slopes.

Keith silt loam, thick, 0 to 1 percent slopes.

Corn, alfalfa, wheat, sorghum, barley, grass (fig. 14), sugar beets, potatoes, and field beans are suitable crops.

These soils are suitable for intensive cultivation without special practices to control runoff or erosion. They require the ordinary good cropping practices, as well as management of irrigation water and use of fertilizer. Land leveling is necessary for furrow and border irrigation in nearly all places. Legumes in the cropping system and green-manure crops are excellent for maintaining high fertility and good soil structure. For high yields, time of applying water, amount of water applied, and even distribution of water are as important as the plant population and a high state of fertility.

Under irrigation and continuous cropping, all these soils respond to nitrogen and phosphorus fertilizers, but to a different degree. The Bridgeport and Havre soils are more responsive to nitrogen and phosphorus, and they also respond to zinc if corn is grown. Sorghum on these two soils tends to yellow because the soils are low in available iron. Applying large amounts of organic matter and barnyard manure will improve the Bridgeport and Havre soils. All these soils respond to nitrogen, phosphorus, and zinc fertilizers where cuts have been made by land leveling.

CAPABILITY UNIT IIe-1, IRRIGATED

The soils in this capability unit are deep, silty, and very gently sloping. They are on uplands and well-drained bottom lands. The soils are—

Bridgeport loam, 1 to 3 percent slopes.

Keith silt loam, 1 to 3 percent slopes.

Keith silt loam, thick, 1 to 3 percent slopes.

Alfalfa, corn, wheat, sorghum, barley, sugar beets, field beans, potatoes, and grass are suitable crops.

These soils are good for irrigation, but runoff and erosion are slight hazards. Special surveys and conservation practices are needed to obtain even distribution of water and to control runoff. Crop rotations that include a legume, or growing of green-manure crops, is needed to keep the soils high in fertility and in good tilth. High

yields can be obtained if the right amount of water is applied at the right time, if the soil is watered equally across the field, and if there is the right number of plants.

Under irrigation and continuous cultivation, crops on these soils respond to nitrogen and phosphorus. The response depends somewhat on past cropping and management. On the Bridgeport soil, crops generally are more responsive to nitrogen and phosphorus than on other soils of this group, and they also respond to zinc. Sorghum tends to yellow because the amount of available iron is low. The Bridgeport soil can be improved by applying manure, returning stubble and other crop residues, and growing grasses and legumes. All of the soils respond to nitrogen, phosphorus, and zinc where cuts have been made by land leveling.

CAPABILITY UNIT IIc-3, IRRIGATED

The soils of this capability unit are moderately sandy, are nearly level or very gently sloping, and are on uplands, on foot slopes, and in well-drained lowlands. The soils are—

Anselmo fine sandy loam, 0 to 1 percent slopes.
Anselmo fine sandy loam, 1 to 3 percent slopes.
Anselmo loamy fine sand, 0 to 3 percent slopes.
Bayard fine sandy loam, 0 to 1 percent slopes.
Bayard fine sandy loam, 1 to 3 percent slopes.
Bayard loamy fine sand, wind-hummocky.
Glendive fine sandy loam.
Goshen fine sandy loam, 0 to 1 percent slopes.
Havre fine sandy loam.
Keith fine sandy loam, 1 to 3 percent slopes.
Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes.
Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes.
Keith fine sandy loam, thick, 0 to 1 percent slopes.
Keith fine sandy loam, thick, 1 to 3 percent slopes.
Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes.

Corn, alfalfa, wheat, sorghum, barley, sugar beets, potatoes, and grass are suitable crops.

The soils in this capability unit are among the best in the county for irrigation, but soil blowing is a moderate hazard. For the most part, the soils are suited only to sprinkler irrigation. Several areas, however, are suited only to the furrow and border methods. The most economical and best functioning method is determined according to the slope. Management of irrigation water is a problem on the more sloping soils. The time of applying water, amount of water applied, and right plant population are essential for high yields.

A good cropping system will leave cover on the soils most of the year, but more especially during fall and winter. Unprotected soil needs a cover crop. Soil that has been leveled especially needs protection from soil blowing.

Fertility is as important as soil cover. Usually a fertile soil will produce enough stalk and stubble to protect it from blowing. Added stubble or crop residue maintains or builds up the content of organic matter. Many of these soils have lost organic matter and fine materials through wind erosion under dryfarming. Thus, under irrigation they are most responsive to nitrogen, phosphorus, and zinc. The Goshen and Keith soils, however, need zinc only on thin spots and leveled places. Legumes and green-manure crops are needed to maintain or improve fertility, soil structure, and tilth.

CAPABILITY UNIT IIIc-1, IRRIGATED

In this unit are deep, silty or loamy, gently sloping soils on uplands and foot slopes. They are—

Bridgeport loam, 3 to 5 percent slopes.
Keith silt loam, 3 to 5 percent slopes, eroded.
Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded.

Wheat, corn, alfalfa, sorghum, and grass are suitable. These soils are only fair for irrigation, however, because management of water and erosion are serious problems. Bench terraces, contour furrows, or other practices are needed. Terraces and contour planting are used with sprinkler irrigation. Corrugations are used for close-growing crops.

Maintaining high soil fertility and applying water at the right time and distributing it evenly are important. Legumes, mixtures of legumes and grasses, and green-manure crops are used in the cropping system. Continuous use of only alfalfa, grass, wheat, or a similar close-growing crop is best, but corn and other row crops can be grown 1 year out of 5.

Barnyard manure is used when available. Crops on these soils respond to nitrogen and phosphorus fertilizers. Corn may need zinc.

CAPABILITY UNIT IIIc-3, IRRIGATED

In this capability unit are deep, moderately sandy soils or deep soils with a moderately sandy surface layer and silty subsoil. These gently sloping soils are on uplands. They are—

Anselmo fine sandy loam, 3 to 5 percent slopes.
Anselmo loamy fine sand, 3 to 5 percent slopes.
Keith fine sandy loam, 3 to 5 percent slopes, eroded.

Wheat, corn, alfalfa, sorghum, and grass are suitable crops. These soils are good for irrigation, but wind and water erosion are hard to control. Contour furrowing, terracing, and other special conservation practices are needed but are not practical in the small areas of these soils that occur within larger, more level areas. Legumes, legume-grass mixtures, and green-manure crops in the rotation help to maintain or improve soil fertility and content of organic matter. Alfalfa, grass, wheat, and other close-growing crops can be grown continuously. Corn and other row crops can be grown not more than 2 years in succession.

Barnyard manure, when available, should be applied. On these soils, small grains and alfalfa respond to additions of phosphorus; small grains, to nitrogen; and corn or sorghum, to nitrogen and zinc.

CAPABILITY UNIT IIIw-6, IRRIGATED

Soils in this capability unit are deep, slightly sandy, nearly level, and in places wet because of a moderately high water table. The one soil of this unit in the county is—

Ovina fine sandy loam, 0 to 1 percent slopes.

Alfalfa, or a mixture of alfalfa and grass, is suitable for this soil. Corn and small grains should not be grown continuously, as the soil tends to be wet in rainy seasons, and it blows when it is dry. Application of water is fairly simple because the soil is nearly level and fine textured. The wetness is a problem, however, and there is no feasible way of establishing drainage.

Growth of crops is limited by soil fertility. Alfalfa responds to a good application of phosphorus fertilizer. Most of this soil is used for native hay or pasture.

CAPABILITY UNIT IIIa-1, IRRIGATED

The soils in this unit are deep or moderately deep over coarse sediments and are affected by moderate amounts of soluble salts or alkali. They are on bottom lands that in most places have a moderately high water table. The soils are—

Las fine sandy loam, saline-alkali.
Las loam, saline-alkali.

Alfalfa, barley, alfalfa-grass mixtures, grass, and sugar beets are suitable crops. Rye, wheat, sorghum, and corn can be grown when it is necessary to plow out and reseed pasture, or they can be grown on the patches less affected by salts or alkali. These cultivated crops should not be grown continuously.

These soils are well suited to grasses and produce abundant, high-quality forage under good management, even under limited irrigation. Frequent, light irrigation of these soils helps plants to get water and leaches the salts to a lower level. In wet seasons the water table may be high enough in the low areas to interfere with tillage. Most of these soils need artificial underground drainage, but this is not practical, in most places, unless highly specialized crops are grown.

Choice of crops is limited. These soils are deficient in available phosphorus for all the suitable crops. Zinc is needed for corn, and nitrogen may be needed for sugar beets, barley, and corn. Applying large amounts of sulfur and other chemical amendments is not practical unless the water table is at least 3 feet or more below the surface and specialized crops are to be grown. Sulfur or other chemical amendments may be used from time to time if the irrigation water contains a high proportion of salts and sodium. Their application, however, is not a substitute for good soil and water management. Amendments may be of no use unless the soil is watered adequately and evenly and unless the right crops and a good cropping system are used. A good one includes legumes. Green-manure crops and barnyard manure are excellent for improving soil fertility and increasing the content of organic matter.

CAPABILITY UNIT IVe-1, IRRIGATED

In this unit are deep, silty, sloping soils on uplands. The soils are—

Ulysses silt loam, 5 to 9 percent slopes.
Ulysses silt loam, 5 to 9 percent slopes, eroded.

Alfalfa, alfalfa-grass mixtures, grass, wheat, rye, and barley are suitable crops. Management of water is a problem, and erosion is a serious hazard. Close-growing crops and terraces help to control erosion.

Special engineering is required to lay out a good system of irrigation. Contour-ditch and sprinkler irrigation are the methods used. Time of applying water and even distribution of water, along with maintenance of soil fertility, are the main requirements under irrigation. Crops respond to phosphorus or nitrogen fertilizer, or to both.

CAPABILITY UNIT IVe-3, IRRIGATED

In this capability unit are deep, moderately sandy, sloping soils on uplands. These soils are—

Anselmo fine sandy loam, 5 to 9 percent slopes.
Anselmo fine sandy loam, 5 to 9 percent slopes, eroded.

Alfalfa, alfalfa-grass mixtures, grass, wheat, rye, and barley are suitable crops. Management of water and control of erosion are serious problems.

Structures carefully designed by an engineer are required to establish a good irrigation system. Contour-ditch and sprinkler irrigation are used. Grassed waterways are needed in some places to carry off surplus water and seepage.

Timely application and even distribution of water, along with maintenance of soil fertility, are important. The suitable small grains and alfalfa respond to phosphorus or nitrogen, or to both.

CAPABILITY UNIT IVe-5, IRRIGATED

The soils in this unit are deep, very sandy, and nearly level to very gently sloping. They are on uplands and bottom lands. The soils in this unit are—

Banks loamy fine sand.
Dunday loamy fine sand.
Dunday loamy fine sand, loam substratum.

Alfalfa, alfalfa-grass mixtures, grass, wheat, barley, rye, corn, and sorghum are suitable crops. Either an alfalfa-grass mixture or alfalfa is best.

These soils are poor to fair for irrigation because blowing is a serious hazard. Management of water is a problem because the soils are very sandy and undulating or uneven. Fertility is also a problem.

Time of applying water, the right amount of water, and even distribution of water are extremely important. Sprinkler irrigation is best.

Cover crops or catch crops will protect open, exposed fields. Legumes and legume-grass mixtures in the crop rotation help to build and maintain soil fertility and the content of organic matter. Barnyard manure is useful when available. These soils respond to nitrogen, phosphorus, and zinc fertilizers. Small grains and alfalfa respond to phosphorus, and small grains may respond to nitrogen. Corn or sorghum responds to nitrogen and zinc.

CAPABILITY UNIT IVw-5, IRRIGATED

In this unit are deep, moderately sandy and very sandy soils that are sometimes wet because of a moderately high water table. These soils are in upland valleys or on bottom lands. The soils are—

Elsmere fine sandy loam, 0 to 1 percent slopes.
Las Animas loamy fine sand.

Alfalfa, grass, and alfalfa-grass mixtures are best suited. Rye, wheat, sudangrass, and sorghum can be used between seedings of alfalfa or alfalfa and grass. These soils can be used for commercial production of grass seed if the grass is planted in rows and cultivated.

The problems are wetness of the soils and management of irrigation water. During dry periods, the soils blow, and they are low in fertility. Cover crops and catch crops on exposed fields help to keep the soils from blowing. During wet seasons, crops may drown out. Time of irrigating, amount of water applied, and even distribu-

tion of water are important. Alfalfa responds to phosphorus fertilizer.

Estimated Yields

Shown in table 1 are estimated average acre yields of principal crops to be expected on the soils of Dundy County under dryland and irrigated farming. In columns A are yields to be expected under current management, and in columns B, yields under improved management.

Under current, or commonly used, management, the farmer or rancher fails to maintain a balance between the practices used under improved management. For example, a farmer can use the adapted crops, grow the crops in a suitable sequence, apply measures for control of erosion, plant at the right time and achieve correct

plant population, and cultivate and harvest correctly, but fail to control insects or plant diseases. The failure to control insects or plant diseases can make the difference in the yield he obtains and that to be expected under improved management.

Under improved management, columns B, the farmer or rancher does these things in proper balance:

1. Controls erosion and conserves water by using cover crops, stubble-mulch tillage, stripcropping, or terracing.
2. Applies appropriate cropping systems, such as a sequence made up of close-growing crops and row crops on dryland, or legumes and green-manure crops with cultivated crops on land irrigated.
3. Tills carefully at the right time, with the right

TABLE 1. -Estimated average acre yields per seeded acre of principal crops

[Yields in columns A are those obtained per seeded acre under prevailing management; those in columns B are approximate average yields per seeded acre attainable under improved management. Absence of a yield figure indicates the crop is not commonly grown or that the soil is not suited to the crop at the level of management specified]

Soil	Corn				Wheat		Sorghum				Alfalfa				Wild hay	
	Dryland		Irrigated		A	B	Grain		Forage		Dryland		Irrigated		A	B
	A	B	A	B			A	B	A	B	A	B	A	B		
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
Anselmo fine sandy loam, 0 to 1 percent slopes	20	27	68	81	16	21	20	29	1.9	2.2	1.6	1.6	3.2	4.5	---	---
Anselmo fine sandy loam, 1 to 3 percent slopes	18	26	65	81	15	20	19	28	1.8	2.2	1.4	1.6	3.1	4.5	---	---
Anselmo fine sandy loam, 3 to 5 percent slopes	17	22	62	73	13	18	17	25	1.6	1.8	1.3	1.4	2.8	3.9	---	---
Anselmo fine sandy loam, 5 to 9 percent slopes	14	16	56	69	11	13	14	18	1.1	1.3	.8	1.0	2.2	3.2	---	---
Anselmo fine sandy loam, 5 to 9 percent slopes, eroded	12	16	50	69	8	13	11	18	.9	1.3	.7	.9	1.8	3.1	---	---
Anselmo fine sandy loam, 9 to 30 percent slopes	9	11	---	---	5	8	9	12	.5	.7	.4	.5	---	---	---	---
Anselmo loamy fine sand, 0 to 3 percent slopes	17	20	62	81	14	20	17	28	1.6	2.2	1.3	1.6	3.0	4.5	---	---
Anselmo loamy fine sand, 3 to 5 percent slopes	15	22	56	71	11	18	15	25	1.4	1.8	1.0	1.2	2.4	3.9	---	---
Banks fine sand	7	10	---	---	3	6	6	11	.5	.9	.7	1.2	---	2.8	---	---
Banks loamy fine sand	11	15	---	55	6	10	8	14	.7	1.0	1.2	2.2	2.2	2.8	---	---
Bayard fine sandy loam, 0 to 1 percent slopes	17	27	58	78	15	20	13	20	1.2	1.8	1.6	2.0	2.7	4.4	---	---
Bayard fine sandy loam, 1 to 3 percent slopes	16	25	54	76	13	18	12	18	1.1	1.6	1.5	1.9	2.6	4.1	---	---
Bayard loamy fine sand, wind-hummocky	14	23	48	70	11	18	10	18	.9	1.5	1.3	1.7	2.3	4.0	---	---
Blown-out land	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bridgeport loam, 0 to 1 percent slopes	15	20	62	85	20	25	12	19	1.1	1.7	1.6	2.0	3.5	5.0	---	---
Bridgeport loam, 1 to 3 percent slopes	14	19	60	79	18	24	11	18	1.1	1.6	1.4	1.8	3.2	4.9	---	---
Bridgeport loam, 3 to 5 percent slopes	12	16	---	70	16	21	9	16	.9	1.4	1.2	1.5	3.0	4.8	---	---
Broken alluvial land	---	---	---	---	---	---	---	---	---	---	.8	1.0	---	---	.3	.6
Canyon fine sandy loam, 3 to 5 percent slopes	5	8	---	---	6	8	6	10	.5	.6	---	---	---	---	---	---
Colby loam, 3 to 9 percent slopes	5	10	---	---	9	12	4	11	.7	1.3	---	---	---	---	---	---
Colby loam, 9 to 30 percent slopes	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dunday loamy fine sand	10	15	45	65	8	12	9	14	.8	1.1	.8	1.2	1.8	3.0	---	---
Dunday loamy fine sand, loam substratum	10	16	---	65	7	12	10	15	1.0	1.3	1.0	1.5	1.8	3.3	.4	.8
Elsmere fine sandy loam, 0 to 1 percent slopes	7	12	---	---	---	---	---	---	---	---	1.0	2.5	---	---	.9	1.4
Elsmere fine sandy loam, 1 to 5 percent slopes	---	---	---	---	---	---	---	---	---	---	---	---	---	---	.7	1.1
Gannett fine sandy loam	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.7	2.2
Glendive fine sandy loam	16	25	52	75	15	21	12	20	1.1	1.7	1.7	2.0	2.7	4.0	---	---
Goshen fine sandy loam, 0 to 1 percent slopes	22	28	---	87	20	24	21	28	2.6	3.2	1.7	1.9	---	4.7	---	---
Goshen silt loam, 0 to 1 percent slopes	18	24	---	90	22	25	19	25	2.4	2.8	1.6	1.8	---	5.0	---	---
Havre fine sandy loam	15	23	56	73	17	23	12	20	1.0	1.6	1.6	1.9	2.6	4.2	---	---
Havre loam	14	21	54	79	19	24	10	17	.9	1.5	1.5	2.0	2.7	4.5	---	---
Las fine sandy loam, saline-alkali	11	15	---	48	8	12	---	---	.5	.6	1.4	2.2	2.2	3.7	.8	1.2
Las loam, saline-alkali	10	14	---	45	7	12	---	---	.4	.5	1.3	2.0	2.0	3.5	.6	1.0
Keith fine sandy loam, 1 to 3 percent slopes	16	23	65	85	18	24	19	28	1.8	2.3	.8	1.0	2.6	4.3	---	---
Keith fine sandy loam, 3 to 5 percent slopes, eroded	14	20	60	75	15	21	17	25	1.4	2.0	.6	.8	2.2	4.0	---	---

TABLE 1.—*Estimated average acre yields per seeded acre of principal crops—Continued*

Soil	Corn				Wheat		Sorghum				Alfalfa				Wild hay	
	Dryland		Irrigated				Grain		Forage		Dryland		Irrigated			
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes.....	Bu. 16	Bu. 25	Bu. 70	Bu. 90	Bu. 19	Bu. 26	Bu. 21	Bu. 30	Tons 2.0	Tons 2.5	Tons 1.3	Tons 1.6	Tons 3.2	Tons 5.0	-----	-----
Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes.....	15	22	59	83	14	20	15	25	1.6	2.1	1.1	1.3	2.8	4.4	-----	-----
Keith fine sandy loam, thick, 0 to 1 percent slopes.....	20	26	75	91	19	26	22	32	2.1	2.5	1.1	1.3	3.4	5.0	-----	-----
Keith fine sandy loam, thick, 1 to 3 percent slopes.....	19	24	72	87	17	24	20	28	2.0	2.4	1.0	1.2	3.2	4.8	-----	-----
Keith silt loam, 1 to 3 percent slopes.....	14	18	-----	84	18	25	16	22	1.5	2.0	-----	-----	-----	4.5	-----	-----
Keith silt loam, 3 to 5 percent slopes, eroded.....	12	16	-----	68	15	21	14	20	1.3	1.8	-----	-----	-----	4.0	-----	-----
Keith silt loam, caliche substratum, 0 to 1 percent slopes.....	14	20	66	85	21	26	19	28	1.8	2.4	1.0	1.3	3.0	4.8	-----	-----
Keith silt loam, thick, 0 to 1 percent slopes.....	15	20	-----	95	23	29	21	30	1.7	2.0	-----	-----	-----	5.0	-----	-----
Keith silt loam, thick, 1 to 3 percent slopes.....	14	18	-----	84	22	27	18	28	1.6	2.0	-----	-----	-----	4.8	-----	-----
Las Animas loamy fine sand.....	9	14	-----	50	-----	-----	11	17	.8	1.2	1.6	2.6	2.6	3.0	.7	1.1
Laurel soils.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.6	1.0	1.0	1.7	-----	-----
Ovina fine sandy loam, 0 to 1 percent slopes.....	6	10	-----	-----	7	11	-----	-----	-----	-----	1.2	2.8	-----	-----	.8	1.2
Platte loam.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.0	1.5
Rauville loam.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.8	2.2
Rough broken land, caliche.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rough broken land, loess.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sandy alluvial land.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.5	.8
Scott silt loam.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded.....	-----	-----	-----	-----	6	11	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded.....	10	15	62	75	14	21	12	23	1.1	1.5	-----	-----	2.6	4.0	-----	-----
Ulysses silt loam, 5 to 9 percent slopes.....	10	14	-----	-----	11	15	13	17	1.2	1.5	-----	-----	-----	-----	-----	-----
Ulysses silt loam, 5 to 9 percent slopes, eroded.....	8	13	-----	-----	9	15	11	15	1.0	1.3	-----	-----	-----	-----	-----	-----
Valentine fine sand, hilly.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valentine fine sand, rolling.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Valentine loamy fine sand.....	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes.....	11	15	-----	48	8	16	13	18	1.0	1.5	-----	-----	-----	2.8	-----	-----

kind of implements, and thus manages crop residue efficiently and controls weeds.

4. Plants adapted crop varieties.
5. Gets proper plant population.
6. Carefully applies water to irrigated land.
7. Consistently controls insects.
8. Applies recommended amounts and kinds of fertilizer at the proper time.

The yield estimates in table 1 are based on information obtained from the Nebraska Annual Statistics, from information furnished by farmers, and from observations and comparisons made by others who are familiar with the soils and agriculture of the county. These estimates are averages per seeded acre, for a 20-year period. They take into account the years of good moisture supply as well as the poor, and also the probable loss through hail and insects.

Variation in yields.—Variation in yields of principal crops from year to year is evident from study of statistics compiled by the Nebraska Department of Agriculture and Inspection for the years, 1937–57 (10).¹

¹ Italic numbers in parentheses refer to Literature Cited, p. 85.

In the 20-year period, 1937–57, wheat yields in the county averaged a little less than 17 bushels per acre seeded, and 19 bushels per acre harvested. Yearly yields could be grouped as follows:

	Bushels per seeded acre
7 years.....	More than 20
5 years.....	15–20
7 years.....	8–15
1 year.....	Less than 8

Corn averaged 13 bushels per seeded acre, and 13.5 bushels per harvested acre in the 20-year period. Yearly yields could be grouped as follows:

	Bushels per harvested acre
3 years.....	More than 20
7 years.....	15–20
3 years.....	10–15
7 years.....	Less than 10

Grain sorghum averaged 13.5 bushels per harvested acre in the 20-year period. Yearly yields could be grouped as follows:

	Bushels per harvested acre
10 years.....	16–20
5 years.....	12–16
5 years.....	Less than 12

During the first 10 years of the 20-year period, hybrid varieties were not used and the crop was cut for grain, rather than forage. Hybrid varieties generally yield higher than the common varieties.

Forage sorghum, in a 19-year period, averaged about 1.4 tons per harvested acre. The yields could be grouped by years as follows:

	Tons per harvested acre
4 years.....	1½ or more
9 years.....	1-1½
4 years.....	¾-1
2 years.....	Less than ¾

In the 20-year period, yields of dryland alfalfa were not separated from yields on irrigated land and, therefore, are not tabulated. In the last 10 years, however, the average yield of dryland alfalfa was 1.2 tons per acre.

According to the foregoing comparison of yields, corn varied the most in yield under dryland farming, and wheat and forage sorghum were more stable in yield.

In table 2 are listed average crop years for five 5-year periods extending from 1932 through 1956. Where information was available, yields are listed for both seeded and harvested acreage.

TABLE 2.—Average crop yields per harvested acre and seeded acre, by 5-year periods, from 1932 through 1956

[Absence of yield indicates data are not available]

Crop	Yield per acre—									
	1932-1936		1937-1941		1942-1946		1947-1951		1952-1956	
	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested
Corn:										
Dryland.....bushel		9.3		10.8	17.7	18.0	17.1	17.5	6.7	7.4
Irrigated.....bushel							48.0		53.0	
Wheat.....bushel	6.1	9.1	12.4	13.8	22.1	24.1	16.7	19.2	16.0	19.2
Grain sorghum.....bushel								15.2		11.4
Alfalfa:										
Dryland.....ton								1.3		.8
Irrigated.....ton								2.7		2.4
Forage sorghum.....ton		1.2		1.3		1.5		1.5		.9
Wild hay.....ton		.64		.77		.86		.76		.45

Use and Management of Rangeland ²

Native grass is the most important crop in Dundy County. A measure of its importance is that 63 percent of the agricultural income in the county, in 1954, was from livestock sold. All of the county was originally covered with grass, and more than half of it remains in, or has been restored to, native grasses. In the sandhills, which make up the western half of the county, only small areas are cultivated. In the eastern half of the county, larger areas of farmland are intermixed with range in all but the two northeastern townships. In these townships, small tracts of range occur within farmlands.

In the past the native grasses, a natural resource, have been exploited. The grasses were almost destroyed in some places, and, in others, seriously depleted. Currently, many ranchers are improving their native range. Others hesitate to undertake such a program because they do not fully understand the benefits or feel they cannot afford the cost.

Actually, the plants that are native are best adapted to the county, and, given reasonable management, they will recover and amply repay the operator for his effort.

To apply appropriate management, however, the operator needs to know the different kinds of rangeland on his holdings, the different combinations of plants they are able to produce, and the effect of grazing on these different plants. As a guide to the manager of rangeland,

the Soil Conservation Service has defined range sites and range condition classes.

Range sites and condition classes

A *range site* is an area of rangeland sufficiently uniform in climate, soils, and topography to produce a particular climax, or original, vegetation. Thus, a given range site needs management different from that of other sites if the desirable vegetation is to be maintained or improved.

The original, or *climax*, vegetation on a range site is that combination of different plants that existed before the white man claimed the land. These plants are the ones that can take full advantage of what the climate and soils have to offer. It is the combination of forage plants that is most productive, and that will survive without the aid of fertilizer, irrigation, cultivation, and similar treatment.

Under intensive grazing, however, the climax vegetation is altered. Livestock graze selectively. They constantly seek the more palatable and nutritious plants. If the grazing is not carefully regulated, the better plants, called *decreasers*, are eventually eliminated. Less desirable plants, called *increasers*, take their place. If grazing pressure is too intense, even the second choice plants are thinned out or eliminated and are replaced by undesirable weeds, or *invaders*.

If rangeland is not grazed, nature will restore the original, or climax, vegetation. This can be observed in a

² By L. F. BREDEMEIER, range conservationist, Soil Conservation Service.

cultivated field that has been abandoned and not pastured. First come the forbs, then the annual grasses, and later, more biennials and perennials. The biennials and perennials have the advantage, since they need not start from seed each year. Range managers use this natural law in restoring range and improving its condition.

Thus, in appraising the condition of range, and planning its management, the basis for comparison is the degree of departure from the original, or climax, vegetation that has been brought about by grazing. Four *condition classes* have been established to show the present condition of the vegetation on a range site in relation to the vegetation that was on it originally. These four classes are as follows:

Condition class:	Percentage of present vegetation that is climax for the site
Excellent	76 to 100
Good	51 to 75
Fair	26 to 50
Poor	0 to 25

The changes in composition of vegetation on a range site under pressure of grazing is illustrated in figure 15.

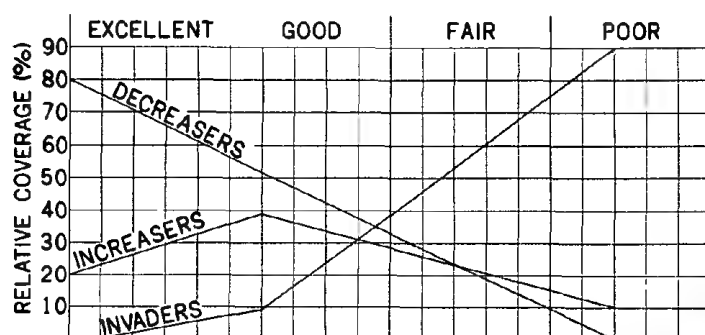


Figure 15.—Diagram illustrating progressive changes in percentage of area covered by decreaseers, increasers, and invaders on a range site at excellent, good, fair, and poor condition classes. (Adapted from article by E. J. Dyksterhuis (6).)

One of the main purposes of good range management is to keep rangeland in excellent or good condition. If this is done, water is conserved, soils are protected, and forage yields remain high. The problem is knowing the kind of cover a range site originally had and recognizing important changes that take place under grazing. These changes take place gradually but should not be misunderstood or overlooked.

To aid the operator in managing rangeland, the soils of the county have been grouped in 11 range sites, each of which is described in the following pages. The relative productivity of each range site is shown in table 3. The ratings in this table indicate relative yield on the various sites, assuming that the Sands, the Sandy, and the Silty range sites, in excellent range condition, have a rating of 100. Thus, in excellent condition, the Wet Land range site is estimated to be three times as productive as the Sands, the Sandy, or the Silty range site. Naturally, production on any given range site, in a stated condition class, will vary from year to year.

WET LAND RANGE SITE

The soils of this range site occur above marshes along the Republican River and at the drainage heads of small

TABLE 3.—Relative productivity of range sites in the four range-condition classes

Range site	Range condition			
	Excellent	Good	Fair	Poor
Wet Land	300	225	150	75
Subirrigated	200	150	100	50
Overflow	130	100	65	35
Saline Lowland	120	90	60	30
Sands ¹	100	75	50	25
Sandy ¹	100	75	50	25
Silty ¹	100	75	50	25
Choppy Sands	80	60	40	20
Shallow	65	50	35	15
Thin Loess	50	40	25	10
Thin Breaks	50	40	25	10

¹ The Sands, the Sandy, and the Silty range sites have a productivity rating of 100 when in excellent condition; the other range sites were rated in comparison with these three sites.

streams. Prairie cordgrass and tall sedges (fig. 16) are dominant when the range is in excellent condition. The soils are mostly too wet for big bluestem, Indiangrass, and switchgrass. The soils of this site are—

Gannett fine sandy loam.
Rauville loam.

The water table is above the surface of these soils early in the growing season. As vegetation grows and transpiration of moisture increases, the water table is drawn down, commonly to a depth of 6 to 24 inches from the surface.



Figure 16.—Wet Land range site showing growth of prairie cordgrass and tall sedges.

The soils of this site produce a good tonnage of forage and are used primarily for hay. The regrowth after harvest is grazed during winter.

SUBIRRIGATED RANGE SITE

The soils of this range site occur between those of the Wet Land site and those of the Sands or the Sandy range sites. Normally they are in valleys within the sandhills, on lower slopes along the sides of spring-fed creeks, and on bottom lands along the Republican River and other streams.

A luxuriant growth of tall grasses, mostly switchgrass, Indiangrass, and big bluestem, predominates when this site is in excellent condition. The soils are—

Elsmere fine sandy loam, 0 to 1 percent slopes.
 Elsmere fine sandy loam, 1 to 5 percent slopes.
 Las Animas loamy fine sand.
 Las fine sandy loam, saline-alkali.
 Las loam, saline-alkali.
 Ovina fine sandy loam, 0 to 1 percent slopes.
 Platte loam.

The water table is rarely above the surface of these soils during the growing season, but it is within reach of roots most of the season. It may be drawn down to a depth 60 inches below the surface but commonly is drawn down to a depth between 36 and 48 inches.

The soils of this site are used primarily for hay because the grasses are of good quality and make good yields. Moreover, early in the season, the soils are, in most places, too wet for grazing.

OVERFLOW RANGE SITE

The soils of this range site occur mainly in small areas, particularly on bottom lands, both in canyons and along large drainageways. The areas, for the most part, are depressional and receive runoff from soils nearby. The soils of this site are—

Broken alluvial land.
 Sandy alluvial land.
 Scott silt loam.

Tall grasses are dominant on this site. In excellent condition the site supports a growth of switchgrass, big bluestem, and western wheatgrass. Since areas are small, these soils are used with adjoining soils.

SALINE LOWLAND RANGE SITE

The soils of this site are mapped as one unit—Laurel soils. They lie along the Republican River in about the same position as soils of the Subirrigated range site. The water table seldom rises above the surface of the soils during the growing season, but accumulations of salt and alkali affect the vegetation.

When this site is in excellent condition, alkali sacaton is dominant, and with it are patches of switchgrass and western wheatgrass. In the wetter areas, alkali cordgrass is important. Saltgrass grows in significant amounts but cannot be used alone in identifying this site, since it grows on other sites that have been overgrazed.

SANDS RANGE SITE

The soils of this range site are on low, gently sloping hummocks, in undulating areas, and on large, rolling dunes and round-topped hills (fig. 17). The soils of this site are—

Banks fine sand.
 Blown-out land.



Figure 17.—Sands range site. Tall and mid grasses dominate when the Sands range site is in good or excellent condition; short grasses increase as the range deteriorates under increased intensity of grazing.

Valentine fine sand, rolling.
 Valentine loamy fine sand.

When this site is in excellent condition, prairie sandreed, sand bluestem, switchgrass, needle-and-thread, and little bluestem predominate. Sand sagebrush is widely spaced because of competition from the grass. Blue grama is in the understory. Under close grazing, blue grama increases and switchgrass, little bluestem, and sand bluestem decrease.

CHOPPY SANDS RANGE SITE

The only soil of this site is Valentine fine sand, hilly. It is on the highest dunes and hills. Slopes are steep and there are sharp peaks and ridges (fig. 18). The soil is a loose sand showing little difference in color from the surface downward.



Figure 18.—Vegetation in good range condition on the Choppy Sands range site.

This range site has more bunchgrasses and fewer grasses that spread by rhizomes than the Sands range site. The more significant grasses are little bluestem, sand bluestem, needle-and-thread, and prairie sandreed. Sandhill muhly is common in spots where range condition is low; sand sagebrush is more significant in the sandier areas. *Yucca* is present in some places.

SANDY RANGE SITE

The soils of this range site are the dark, nearly level loamy fine sands of the sandhills and the undulating to steep sandy loams and fine sandy loams around the sandhills (fig. 19). The soils are—

Anselmo fine sandy loam, 0 to 1 percent slopes.
 Anselmo fine sandy loam, 1 to 3 percent slopes.
 Anselmo fine sandy loam, 3 to 5 percent slopes.
 Anselmo fine sandy loam, 5 to 9 percent slopes.
 Anselmo fine sandy loam, 5 to 9 percent slopes, eroded.
 Anselmo fine sandy loam, 9 to 30 percent slopes.
 Anselmo loamy fine sand, 0 to 3 percent slopes.
 Anselmo loamy fine sand, 3 to 5 percent slopes.
 Banks loamy fine sand.
 Bayard fine sandy loam, 0 to 1 percent slopes.
 Bayard fine sandy loam, 1 to 3 percent slopes.
 Bayard loamy fine sand, wind-hummocky.
 Dunday loamy fine sand.
 Dunday loamy fine sand, loam substratum.
 Glendive fine sandy loam.
 Goshen fine sandy loam, 0 to 1 percent slopes.
 Havre fine sandy loam.
 Keith fine sandy loam, 1 to 3 percent slopes.
 Keith fine sandy loam, 3 to 5 percent slopes, eroded.
 Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes.
 Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes.
 Keith fine sandy loam, thick, 0 to 1 percent slopes.
 Keith fine sandy loam, thick, 1 to 3 percent slopes.
 Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes.

Needle-and-thread and sand dropseed, with clones of prairie sandreed and an understory of blue grama, are dominant on this range site. Sand sagebrush is not significant when this site is in excellent condition. The vegetation on this site varies somewhat according to location. Switchgrass and some little bluestem will grow on the nearly level loamy fine sands in the sandhill areas. More of the little bluestem and a very little switchgrass grow on the steeper sandy loams and fine sandy loams.



Figure 19.—Sandy range site in good range condition.

Where sandy loams and fine sandy loams are associated with silts, the plant cover is a small amount of side-oats grama, with some bluestem, needle-and-thread, sand dropseed, and sandreed.

SILTY RANGE SITE

The soils of this range site are in small areas associated with areas of the Thin Loess range site. The soils of this site are dominantly loams and silt loams (fig. 20).



Figure 20.—Silty range site in October; range is in good condition at end of the grazing season.

They have a distinct surface layer and subsoil. The soils of this site are—

Bridgeport loam, 0 to 1 percent slopes.
 Bridgeport loam, 1 to 3 percent slopes.
 Bridgeport loam, 3 to 5 percent slopes.
 Colby loam, 3 to 9 percent slopes.
 Colby loam, 9 to 30 percent slopes.
 Goshen silt loam, 0 to 1 percent slopes.
 Havre loam.
 Keith silt loam, 1 to 3 percent slopes.
 Keith silt loam, 3 to 5 percent slopes, eroded.
 Keith silt loam, caliche substratum, 0 to 1 percent slopes.
 Keith silt loam, thick, 0 to 1 percent slopes.
 Keith silt loam, thick, 1 to 3 percent slopes.
 Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded.
 Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded.
 Ulysses silt loam, 5 to 9 percent slopes.
 Ulysses silt loam, 5 to 9 percent slopes, eroded.

When in excellent condition, the vegetation on this site is dominantly western wheatgrass, needle-and-thread, and blue grama, with some side-oats grama and little bluestem on the steeper slopes. When the mid grasses are grazed out, blue grama, buffalograss, red three-awn, annuals, and other less desirable plants make up the vegetation.

For the most part, soils of this site are nearly level to moderately sloping. Most of the acreage is cultivated, but small areas that occur in association with the Thin Loess range site are grazed.

THIN LOESS RANGE SITE

The only mapping unit in this range site is Rough broken land, loess, which consists of silty and limy loess or of similar material that has been cut by many small channels or drainageways (fig. 21).

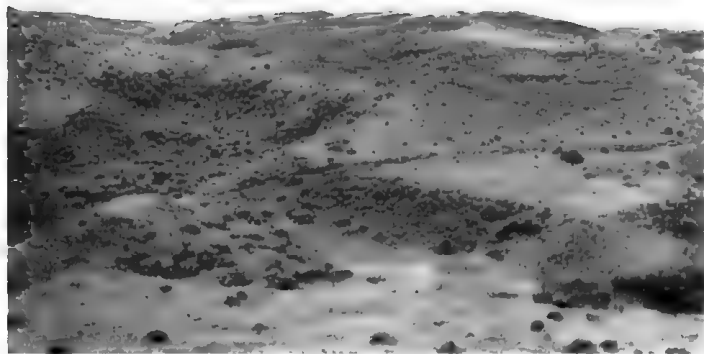


Figure 21.—Thin Loess range site in October; land closely grazed but in good range condition.

When the range is in excellent condition, the vegetation consists of little bluestem, side-oats grama, and needle-and-thread, with some blue grama, western wheatgrass, and big bluestem. This land is thin, steeply sloping, and suitable only for grazing.

SHALLOW RANGE SITE

This range site includes only one soil, Canyon fine sandy loam, 3 to 5 percent slopes. It consists of 10 to 20 inches of soil material over unweathered parent material, primarily calcareous sandstone of the Ogallala formation. This land is used only for grazing. When the range is in excellent condition, the plant cover consists of needle-and-thread, side-oats grama, and blue grama, with some little bluestem, upland sedges, and western wheatgrass.

THIN BREAKS RANGE SITE

Rough broken land, caliche, is the only mapping unit in this range site. This land is near the heads of Rock and Buffalo Creeks and in Rock Canyon. The soil material ranges from very shallow to deep and is of mixed textures. About half of the acreage is barren; the rest is very shallow, sparsely vegetated land on upper slopes and areas in deep pockets among rock outcrops. The vegetation on this site varies widely, but side-oats grama and little bluestem are most common.

Principles of managing rangeland

If range is to be managed efficiently, four major requirements are to be met:

1. Use the range to the proper degree, considering the kinds of range plants it is producing or can produce.
2. Graze the range at the proper season, taking into account the needs of the kinds of range plants, the need for improvement, and the seasonal needs of forage for livestock.

3. Distribute grazing throughout the pasture, so that the degree of grazing in all parts will be as even as it is practical to achieve.
4. Put the proper kinds of livestock on the range, taking into account the needs of the livestock, the kind of forage the range site produces, and the effect grazing animals will have on the plant cover.

PROPER DEGREE OF USE

If range is used to the proper degree, enough leaf surface is left to maintain vigor of the range plants and to provide cover that will protect the soils. By observation and field experience, it has been learned that proper use of range means grazing about half of the growth that the desirable forage plants make in one year. The remaining half gives grasses an opportunity to manufacture and store sufficient plant food to maintain vigor. If not more than half of the current year's growth is removed, range in excellent or good condition will maintain high production, and if range is depleted, will permit gradual but steady improvement. Proper degree of grazing is the first and most important step in range management.

Proper season of use.—As previously indicated in the discussion of range sites, different areas of range produce a different combination of plants. Some grasses make their best growth in cool seasons, as in spring or fall. Others grow better during the warm season. The grasses propagate in different ways—some by seeding alone, and others by seeding and spread of shoots or roots. Thus, the efficient operator takes into account the growth habits of the plants on his range, and by grazing or resting the grass at appropriate times, increases the rate of range improvement, and gets maximum production of forage.

Deferred grazing.—Though not directly related to season of use, deferred grazing is one of the practices valuable in range improvement. Range improves more rapidly if grasses grow unmolested during an entire season. The undisturbed grasses leave a mulch at the surface, which improves infiltration of snowmelt and rainfall. Growth of the taller, more productive kinds of plants is thus encouraged.

A deferment of as little as three consecutive months may be effective on some ranges. Others may need two full growing seasons of complete rest before there is obvious improvement. The forage left on rangeland after deferment through the growing season can be grazed after the hard frosts in fall. For best results, the stock will need protein supplements when placed on this dry forage.

Where severe overgrazing has eliminated the original productive grasses, the best method of restoration is reseeded to native grasses. Reseeding of range is discussed in detail under the heading "Range Seeding."

Grazing distribution.—If grazing is of the desirable kind that takes half the year's growth and leaves the rest, the animals often will not go to the far corners and inaccessible places. Only severe grazing will force them to do this, and such grazing is not desirable.

Thus, under proper grazing pressure, practices are needed that will encourage better use of the entire pasture. First, if there are noticeable differences in the kinds of plants in the different parts of the pasture, those parts having essentially the same vegetation can be

fenced separately. This will allow stocking the various kinds of vegetation in more appropriate relation to needs of the plants and the amount of forage produced. Fencing allows grazing at the proper season of use. Also, fences can be used to keep livestock on the hilly land, in spite of their preference for grazing the more nearly level areas.

Distribution of grazing also can be encouraged by locating watering places strategically. Generally, cattle will travel about three-fourths of a mile to water on steep or rough land, and a mile on gently rolling land. Thus, the distance between wells or other watering places will vary according to the terrain. Watering places should be numerous enough to prevent livestock from congregating around the water in large numbers and for long periods of time. Generally, one watering place is needed for each 40 to 60 animal units.

One of the most economical and effective ways of getting distribution of grazing is to place salt and mineral supplements in areas that normally are grazed the least and to change locations from time to time. There should be no salt at watering places, as this increases trampling and grazing at these sites.

PROPER KINDS OF LIVESTOCK

Cattle, sheep, and other livestock have different habits of grazing that have significantly different effects on range plants. In Dundy County experience has led to a preference for cattle. Most of the operators use their range for cattle. A few run some sheep.

RANGE SEEDING

Some rangeland, through overgrazing, is so depleted that it can be restored more quickly and economically by seeding than by deferred grazing or other less intensive methods of range improvement. The time for recovery of the range would be too long. In other places, reseeding will hasten the recovery of range that is not so seriously depleted.

Native grasses are suitable for reseeding in this county, and the seed should be from locally adapted strains. Once established, such grasses maintain high vigor and production with essentially no "out of pocket" cost. Range reseeding is appropriate for soils of classes VI and VII, as these are nonarable soils. Once grass is established on them, they will not require renovation, or reseeding if they are properly managed. Also suitable for reseeding are areas of land in classes I through IV that are too small to cultivate separately or to graze and manage as a separate pasture (fig. 22).

Seedbed preparation.—To establish a seeding of grasses, it is necessary to prepare a good seedbed. The land is tilled to destroy existing vegetation and to reduce to a minimum the annual and perennial plants that will compete with the grasses the first 2 years. Then, around June 1 to July 15, sorghum or sudangrass is seeded to provide a cover crop that will control erosion. Normally, 6 to 10 pounds per acre of sorghum is sown, the actual amount depending on the spacing of the drill rows. Drill rows should not be more than 20 inches apart, so that sufficient mulch will be provided. The sorghum or milo is clipped to prevent its forming seed. The standing stubble can be left 10 to 18 inches high so that it



Figure 22.—Top, two-year-old stand of native grasses. Bottom, same field before reseeding. Drought is so frequent in this county that few farmers will risk seeding grass other than for the purpose of gaining permanent pasture.

will prevent blowing, catch and hold snow, and protect the new grass seeding. Grasses are seeded from November 1 to May 15.

Large fields of loamy fine sands or coarser textured soils, or of soils that are hummocky, should be broken in strips and the seeding spread over several years. Under some conditions, and especially on fine sands and hummocky loamy fine sands, there may be a sparse stand of one or two desirable grasses that should not be destroyed, even in strips. Here, it is best to sow a mixture of the high-producing climax grasses in shallow, wide furrows made with a range interseeder (fig. 23).

Seeding methods and mixtures.—Range should be seeded to a mixture of adapted strains of the grasses originally present. The different kinds of grasses should be seeded in proportions that will result in a stand as nearly like the climax vegetation as possible. The mixture for seeding will therefore vary with the site. Information on appropriate mixtures can be obtained from local representatives of the Soil Conservation Service.



Figure 23.—Seeding native grasses. *Top*, range seeder developed by Soil Conservation Service to interseed climax native grasses where the hazard of erosion is too great for other seedbed preparation. *Bottom*, rows of native grasses interseeded in depleted native cover, after one season of growth.

Results are best if grass is drilled in a cover crop. The drill needs seedboxes that will handle light, fluffy seed and the small, easily flowing seed. It is desirable that the seed be placed in the ground, then covered and packed. If the drill is not equipped to pack as seeding progresses, a packer should be used.

Broadcast seeders have been used with some success. After broadcasting, however, treaders and packers or other machinery are needed to cover the seed and firm the soil over it.

Attempts to drill or broadcast grass seed in a stand of vegetation that includes perennials has consistently failed. This is a waste of seed and money. Where it is not desirable to destroy existing vegetation, the range

interseeder can be used, as previously explained. The interseeder should be run just deep enough to cut under the present vegetation and to leave a clean furrow for seeding.

Land can be seeded to native grasses with little outlay of cash if late-cut hay containing seed is fed to livestock on the land to be revegetated. The advantages of this method are that native strains of seed are used and the hay not eaten provides a mulch that helps control erosion, insures a more abundant and steadier supply of moisture, and keeps soil temperatures more uniform. Use of this method is limited by the amount of hay available, the difficulty of scattering hay over large acreages, and, infrequently, lack of equipment for handling hay. Moreover, a good mixture of all native grasses is difficult to get because the seed of the different grasses does not mature at the same time.

Newly seeded grass should not be grazed until it is well rooted. Generally, two seasons of growth is required. After the end of the second growing season, judicious grazing in fall and winter can be done. It is wise to graze new stands only in fall and winter until the stand is thick enough to keep most annuals from growing. Excess growth of weeds can be controlled by mowing or spraying.

Cattle tend to graze more heavily on formerly farmed fields and in newly seeded areas. For this reason, fields and new pastures should be fenced to control grazing until the stand is established. Then, seeded range can be managed the same as other range.

CONTROLLING BLOWOUTS

Blowouts are areas in sandy soils where vegetation has been destroyed by plowing or severe grazing (fig. 24). There are 6,783 acres of Blown-out land in Dundy County.

Sand drifting from these blowouts cuts off vegetation and endangers areas nearby. The problem is to hold the sand in place so that grass can revegetate and stabilize the blowout.

In pastures, blowouts can be stabilized in as little as a year if the area is fenced and there is a source of seed sufficient to start growth of annuals and weedy plants. Since the blowout is protected by a fence, grasses eventually take the place of the weeds and annuals.

In large bare areas stabilization can be hastened by seeding quick-growing summer crops. Sorghum has been most effective. They are planted after the windiest part of the season and when growth is rapid. A mixture of native grasses is seeded in the dead sorghum the following spring. When the major part of the blowout has been thus stabilized, the steep banks are sloped, packed, planted to a mixture of native grasses, and mulched. If these banks are not smoothed down, or sloped, they will not grow grass and are a constant source of drifting sand.

Mature native hay that contains seed can be used when slopes are seeded. The hay mulch can be held in place with stakes, or by treading it partly into the sand, or by spraying on a light coat of RC-2 asphaltic oil.

Where blowouts are numerous, or where fencing is otherwise impractical, pastures can be set aside for grazing only in fall and winter. Stabilized blowouts can be grazed lightly and with caution.

Management of native meadows

Areas of native grasses that are mowed regularly for hay are known as meadows. Most of these meadows are on soils in the Wet Land, the Subirrigated, and the Saline Lowland range sites. The vegetation is primarily tall and mid grasses and sedges. A considerable amount of the original cover was forbs, but mowing has reduced these markedly, and it has also reduced the amount of tall grasses and sedges.

Depending on the range site and the condition of the vegetation, native hay meadows in Dundy County produce from $\frac{1}{4}$ to $1\frac{3}{4}$ tons of hay per acre. The average yield in the period 1944-49 was 0.8 ton per acre (10).

Production from native hay meadows can be maintained or improved by giving the native grasses opportunity to manufacture and store in their roots a good reserve supply of carbohydrate. Maximum storage occurs when seed is ripening and the spring foliage is drying (8). Different range plants grow and mature at different times. Early clipping reduces forbs and native legumes, as a group, more than the grasses (5).

Fertilization.—Experiments conducted on native meadows in Nebraska, but not in this county, indicate that fertilization offers possibilities of increased yield. The meadows treated, however, varied widely in their response to fertilizer (4). Several ranchers in Dundy County have fertilized some plots in native meadows. In most places there was no visible response.

Mowing time and height.—Grass makes better hay if cut early, and weaned calves make better daily gains if wintered on such hay (3), but the tonnage harvested is better if hay is cut late.

Ranchers must choose between higher nutritional value of the hay cut early or the greater tonnage from hay cut late. Their experience seems to favor a reasonable compromise, which is to mow the meadows early enough to allow regrowth and numerous seed stalks at the end of the growing season. This regrowth gives plants a chance to manufacture and store the food they need to get off to a good start the following year. The regrowth should not be mowed or grazed until after the end of the growing season.

On the Wet Land and Subirrigated range sites, grazing during the dormant season seems to have little effect on yield in the following year. Soils of these sites receive moisture from the underlying water table. On the Sands and Sandy range sites, however, the regrowth is needed to catch and hold snow that will replenish the moisture supply.

Height of mowing is important in maintaining desirable grasses and obtaining high production. Tall grasses, sedges, and forbs produce most of the hay in native meadows. When they are mowed, the meristem tissue, or growing region, of the plant is removed. These plants must then activate buds below the place where they were cut. In the hay grasses, most of the bud shoots thus activated are at or below the surface of the soil. It takes time for the new shoots to grow to a size that will allow them to manufacture and store plant food.

Short grasses, in contrast to the tall, generally lose only their top leaves during mowing. Their meristem tissue is not removed, so growth continues without delay.

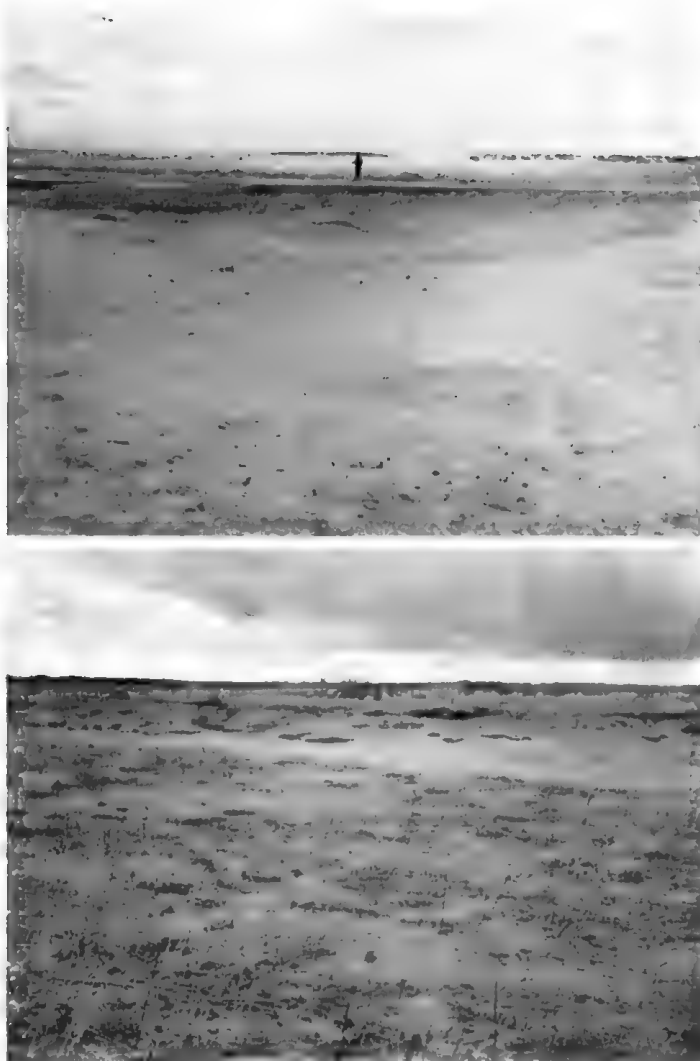


Figure 24.—Top, blowout that formed through farming a sandy soil. Bottom, same area two growing seasons later. The cover crop planted 2 years ago produced a poor stand but helped annual weeds to get established.

Thus, the short grasses gain advantage over the tall and will therefore increase. A soil that produces both short and tall grasses is not the best for hay meadows. In some instances, however, it is necessary to mow such an area for hay. When this is done, it should be mowed not more than once in 3 to 5 years. Then, in the summer following the mowing, it should not be grazed. In fall and winter, however, grazing can be started again.

Woodland and Windbreaks

Natural growth of trees in Dundy County is chiefly on the lowlands along the Republican and Arikaree Rivers and, to a limited extent, in the valleys of the sandhills and in the canyons of the hardlands. Flooded areas along the Republican River support dense stands of cottonwoods. Scattered American elm, hackberry, boxelder, green ash, and cottonwood occupy the adjacent drier sites and areas along most of the smaller flowing streams.

Sandbar willow grows on the sandbars of the rivers and larger creeks. Honeylocust, probably brought in by early settlers, has become adapted and grows in spotted stands in the low valleys of the sandhills where moisture is favorable. A few redcedar trees grow along drainage-ways in the loess hills and canyons.

The native shrubs in the county are wild plum, choke-cherry, buffaloberry, three-leaved sumac, smooth sumac, wax currant, golden currant, and western sand cherry. These shrubs grow in sheltered places in the uplands and along streams where moisture is favorable.

Windbreaks

Trees have been planted for windbreaks and beautification since the time of early settlement. Much of the better farmland was taken under the Timber Culture Act in the early 1880's, and many of these old timber claims can still be seen.

The benefits from windbreaks are many, and they more than repay the planter for the expense and labor involved in establishing them. They prevent snow from drifting in yards, reduce home heating costs, provide shelter for livestock, reduce cost of feed, invite insect-eating birds and other wildlife, protect gardens, and beautify the home (fig. 25).



Figure 25.—A farmstead protected by a good windbreak.

Starting trees in Dundy County is not easy but can be done if the site is carefully prepared, species appropriate for the climate are selected, the planting stock is carefully handled, and the site is cultivated and protected during the first 5 or 6 years.

The amount of preparation necessary for planting young trees will vary for the different soils. For the heavier soils and for all areas sodded or in alfalfa, stubble-mulch fallow is needed for a year preceding seeding, to increase soil moisture and to reduce the amount of competing vegetation. Where medium-textured soils have been cultivated and there is a good supply of moisture, subsurface tillage in the fall and plowing and disking in spring is adequate preparation. If irrigation

water is available, complete soaking of the soil before planting will assure a better stand of trees. For best results in the sandhills, planting of trees is confined to narrow bands. A band is prepared for each row of trees and a strip crop or crop stubble is left between the rows, to control soil blowing. If cover is light or lacking, sorghum, sudangrass, or millet is seeded to protect the site.

Windbreaks for farmsteads or livestock.—For winter protection of farmsteads or livestock, windbreaks are best if they are 10 or more rows wide, so that most of the snow is held within the windbreaks. They are best located on the north and west sides of the area to be protected, and not closer than 100 feet from the main farm buildings.

A combination of low shrubs, shrubs or trees of medium height, and tall-growing trees provides a satisfactory wind barrier. For adequate winter protection of an area, and for longer life of the windbreak, at least 50 percent of the windbreak should be redcedar, pine, or other conifers. Redcedar, with its dense growth to the ground, is excellent for the outside rows.

Field windbreaks or shelterbelts.—Belts of trees are of particular value in controlling wind erosion on sandy soils used for crops (fig. 26). Such belts afford protection for a distance equal to about 20 times the height of the barrier. A field, therefore, can be completely protected by planting a series of belts at regular intervals across the field. Wide belts are not necessary. Belts 1 to 3 rows are wide enough. Redcedar, pine, and similar dense-growing trees are best for this purpose because they will not sap moisture from the field.



Figure 26.—Eight-year-old field windbreak northwest of Haigler. This windbreak will owe much of its effectiveness to the rows of redcedar trees.

A complete pattern of field windbreaks helps to control soil blowing, increases soil moisture by holding snow on the field, prevents strong winds from damaging growing crops, reduces evaporation of moisture, and furnishes food and cover for wildlife.

Woodland sites

The soils of Dundy County have been placed in eight woodland sites. All the soils of one site are similar in those characteristics that affect growth of trees and are suited to about the same species. Table 4 lists the woodland sites, the soils in each site, and species suitable for each site.

TABLE 4.—Woodland sites and species suitable for planting

SILTY TO CLAYEY WOODLAND SITE

Description of site, practices, and suitable planting stock	Soils in woodland site	Map symbol	Dry-land capability unit
<p><i>Deep, well-drained, silty, clayey, or claypan soils, except saline-alkali soils:</i></p> <p>Satisfactory growth once trees are established. Wind, blowing of soil, and drought are among the hazards. These can be overcome by summer-fallow preparation of the planting site, cover cropping, clean cultivation, and watering when needed. Important are good-quality planting stock, careful handling of trees to prevent drying, and careful planting.</p> <p>Suitable for planting:</p> <p>Shrubs: American plum, western chokecherry, common lilac, cotoneaster, Tartarian honeysuckle.</p> <p>Conifers: redcedar, Rocky Mountain juniper, ponderosa pine, Austrian pine.</p> <p>Low broadleaf: Russian-olive, mulberry.</p> <p>Medium and tall broadleaf: green ash, hackberry, thornless honeylocust, Siberian elm.</p>	<p>Bridgeport loam, 0 to 1 percent slopes.....</p> <p>Bridgeport loam, 1 to 3 percent slopes.....</p> <p>Bridgeport loam, 3 to 5 percent slopes.....</p> <p>Rough broken land, loess.....</p> <p>Colby loam, 3 to 9 percent slopes.....</p> <p>Colby loam, 9 to 30 percent slopes.....</p> <p>Goshen silt loam, 0 to 1 percent slopes.....</p> <p>Havre loam.....</p> <p>Keith silt loam, 1 to 3 percent slopes.....</p> <p>Keith silt loam, thick, 0 to 1 percent slopes.....</p> <p>Keith silt loam, caliche substratum, 0 to 1 percent slopes.....</p> <p>Keith silt loam, thick, 1 to 3 percent slopes.....</p> <p>Keith silt loam, 3 to 5 percent slopes, eroded.....</p> <p>Ulysses silt loam, 5 to 9 percent slopes.....</p> <p>Ulysses silt loam, 5 to 9 percent slopes, eroded.....</p> <p>Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded.....</p> <p>Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded.....</p>	<p>Bh</p> <p>BhA</p> <p>BhB</p> <p>BL</p> <p>CdCW</p> <p>CdDW</p> <p>Gh</p> <p>Hh</p> <p>KeAW</p> <p>2Ke</p> <p>4Ke</p> <p>2KeA</p> <p>KeB2</p> <p>UsC</p> <p>UsC2</p> <p>2UC2</p> <p>2UC3</p>	<p>IIC-1.</p> <p>IIE-1.</p> <p>IIIe-1.</p> <p>VIIe-1.</p> <p>IVe-1.</p> <p>VIe-1.</p> <p>IIC-1.</p> <p>IIE-1.</p> <p>IIE-1.</p> <p>IIE-1.</p> <p>IIE-1.</p> <p>IIE-1.</p> <p>IVe-1.</p> <p>IIIe-1.</p> <p>VIe-1.</p>

SANDY WOODLAND SITE

<p><i>Slightly sandy soils and nearly level, very sandy soils:</i></p> <p>Good soils for planting if soil blowing is preventing by cultivating only in tree rows and leaving strips of vegetation between rows.</p> <p>Suitable for planting:</p> <p>Shrubs: American plum, western sandcherry, lilac.</p> <p>Conifers: redcedar, Rocky Mountain juniper, ponderosa pine.</p> <p>Low broadleaf: boxelder, Russian-olive, mulberry.</p> <p>Medium and tall broadleaf: green ash, thornless honeylocust, cottonwood, Siberian elm.</p>	<p>Anselmo fine sandy loam, 0 to 1 percent slopes.....</p> <p>Anselmo fine sandy loam, 1 to 3 percent slopes.....</p> <p>Anselmo fine sandy loam, 3 to 5 percent slopes.....</p> <p>Anselmo fine sandy loam, 5 to 9 percent slopes.....</p> <p>Anselmo fine sandy loam, 5 to 9 percent slopes, eroded.....</p> <p>Anselmo fine sandy loam, 9 to 30 percent slopes.....</p> <p>Anselmo loamy fine sand, 0 to 3 percent slopes.....</p> <p>Anselmo loamy fine sandy, 3 to 5 percent slopes.....</p> <p>Banks loamy fine sand.....</p> <p>Bayard fine sandy loam, 0 to 1 percent slopes.....</p> <p>Bayard fine sandy loam, 1 to 3 percent slopes.....</p> <p>Bayard loamy fine sand, wind-hummocky.....</p> <p>Dunday loamy fine sand.....</p> <p>Dunday loamy fine sand, loam substratum.....</p> <p>Glendive fine sandy loam.....</p> <p>Goshen fine sandy loam, 0 to 1 percent slopes.....</p> <p>Havre fine sandy loam.....</p> <p>Keith fine sandy loam, 1 to 3 percent slopes.....</p> <p>Keith fine sandy loam, thick, 1 to 3 percent slopes.....</p> <p>Keith fine sandy loam, 3 to 5 percent slopes, eroded.....</p> <p>Keith fine sandy loam, thick, 0 to 1 percent slopes.....</p> <p>Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes.....</p> <p>Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes.....</p> <p>Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes.....</p>	<p>An</p> <p>AnA</p> <p>AnB</p> <p>AnC</p> <p>AnC2</p> <p>AnD</p> <p>AoAW</p> <p>AoBW</p> <p>Bc</p> <p>Bf</p> <p>BfA</p> <p>BfA2</p> <p>Du</p> <p>2Du</p> <p>Gd</p> <p>Gf</p> <p>Hf</p> <p>KfAW</p> <p>2KfA</p> <p>KfB2</p> <p>2Kf</p> <p>4Kf</p> <p>4KfW</p> <p>3VfA</p>	<p>IIE-3.</p> <p>IIIe-3.</p> <p>IIIe-3.</p> <p>IVe-3.</p> <p>IVe-3.</p> <p>VIe-3.</p> <p>IIIe-3.</p> <p>IIIe-3.</p> <p>IIE-5.</p> <p>IIE-3.</p> <p>IIIe-3.</p> <p>IVe-5.</p> <p>IVe-5.</p> <p>IIE-3.</p> <p>IIE-3.</p> <p>IIIe-3.</p> <p>IIE-3.</p> <p>IIE-3.</p> <p>IIIe-3.</p> <p>IVe-3.</p>
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VERY SANDY WOODLAND SITE

<p><i>Very sandy soils and loose, sandy soils that cannot be cultivated safely:</i></p> <p>Soils are so loose that trees should be planted in a shallow furrow and not cultivated. Only plantings of conifers can succeed on this site.</p> <p>Suitable for planting:</p> <p>Conifers: redcedar, Rocky Mountain juniper, ponderosa pine.</p>	<p>Blown-out land.....</p> <p>Banks fine sand.....</p> <p>Valentine fine sand, rolling.....</p> <p>Valentine fine sand, hilly.....</p> <p>Valentine loamy fine sand.....</p>	<p>B</p> <p>Bb</p> <p>VaC</p> <p>VaD</p> <p>Vb</p>	<p>VIe-5.</p> <p>VIe-5.</p> <p>VIe-5.</p> <p>VIIe-5.</p> <p>VIe-5.</p>
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TABLE 4.—Woodland sites and species suitable for planting—Continued

MODERATELY WET WOODLAND SITE

Description of site, practices, and suitable planting stock	Soils in woodland site	Map symbol	Dry-land capability unit
<p><i>Soils of bottom lands and upland valleys that are wet at times because of high water table, flooding, or frequent flooding of short duration:</i></p> <p>Good soils for planting if the trees and shrubs selected will tolerate occasional wetness.</p> <p>Suitable for planting:</p> <p>Shrubs: American plum, buffaloberry, common lilac, Tartarian honeysuckle, red-osier dogwood.</p> <p>Conifers: redcedar, and Austrian pine on drier areas.</p> <p>Low broadleaf: Russian-olive, diamond willow.</p> <p>Medium and tall broadleaf: golden willow, cottonwood, white willow, and in drier areas, green ash, hackberry, thornless honeylocust, Siberian elm.</p>	<p>Elsmere fine sandy loam, 0 to 1 percent slopes.....</p> <p>Elsmere fine sandy loam, 1 to 5 percent slopes.....</p> <p>Las Animas loamy fine sand.....</p> <p>Ovina fine sandy loam, 0 to 1 percent slopes.....</p> <p>Sandy alluvial land.....</p> <p>Broken alluvial land.....</p>	<p>Es</p> <p>EsC</p> <p>Ln</p> <p>Ov</p> <p>Sx</p> <p>Sy</p>	<p>IVw-5.</p> <p>VIw-5.</p> <p>IVw-5.</p> <p>IVw-6.</p> <p>VIw-1.</p> <p>VIw-1.</p>

WET WOODLAND SITE

<p><i>Soils of bottom lands and upland depressions extremely wet because of flooding, high water table, or poor drainage:</i></p> <p>Soils suitable only for those species tolerant of wetness.</p> <p>Suitable for planting:</p> <p>Shrubs: purple willow, red-osier dogwood.</p> <p>Conifers: none suitable.</p> <p>Low broadleaf: diamond willow.</p> <p>Medium and tall broadleaf: golden willow, white willow, cottonwood.</p>	<p>Gannett fine sandy loam.....</p> <p>Platte loam.....</p> <p>Rauville loam.....</p> <p>Scott silt loam.....</p>	<p>Ga</p> <p>Pt</p> <p>Ra</p> <p>Sc</p>	<p>Vw-1.</p> <p>Vw-1.</p> <p>Vw-1.</p> <p>VIw-1.</p>
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MODERATELY SALINE-ALKALI WOODLAND SITE

<p><i>Moderately saline or alkali soils:</i></p> <p>Soils suitable only for those species somewhat tolerant of moderate concentrations of salts or alkali.</p> <p>Suitable for planting:</p> <p>Shrubs: buffaloberry, American plum, red-osier dogwood.</p> <p>Conifers: redcedar.</p> <p>Low broadleaf: Russian-olive, diamond willow.</p> <p>Medium and tall broadleaf: green ash, thornless honeylocust, Siberian elm, cottonwood.</p>	<p>Las fine sandy loam, saline-alkali.....</p> <p>Las loam, saline-alkali.....</p>	<p>2Ls</p> <p>2Lt</p>	<p>IVs-1.</p> <p>IVs-1.</p>
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SHALLOW WOODLAND SITE

<p><i>Shallow soils with limited root zone above bedrock, shale, or gravel:</i></p> <p>Soils suitable for limited planting. Windbreaks seldom needed because soils normally are not cultivated. Careful determination of depth of soils should be made before an area is planted.</p> <p>Suitable for planting:</p> <p>Conifers: redcedar or Rocky Mountain juniper are likely the only species that will survive and attain reasonable height.</p>	<p>Canyon fine sandy loam, 3 to 5 percent slopes.....</p>	<p>CgB</p>	<p>VIIs-4.</p>
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NOT PLANTABLE WOODLAND SITE

<p><i>Strongly saline or alkali soils and steep, very shallow soils:</i></p> <p>Some areas support a growth of sandbar willow; soils of this woodland site are not suitable for planting.</p>	<p>Rough broken land, caliche.....</p> <p>Laurel soils.....</p>	<p>BCa</p> <p>LS</p>	<p>VIIIs-3.</p> <p>VIIs-1.</p>
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Maintaining plantings

Young trees need clean cultivation until they are large enough to form a canopy that will shade out competing grasses and weeds (fig. 27). If the trees are to survive, cultivation will continue for 5 to 6 years after planting. Survival of newly planted trees is better if cultivation is confined to the rows of trees and the strips between rows are planted to corn, sorghum, or similar tall cover crops that provide protection from strong winds and the hot sun. A heavy watering later in fall will prevent winter winds from drying out the trees and provide the moisture needed for spring growth.

If a good wind barrier is to be maintained, livestock must be kept out of the windbreak, regardless of its age.



Figure 27.—A spring-tooth harrow is excellent for cultivating plantings of young trees.

Wildlife

Pioneer stories tell of abundant fish and game in the territory that is now Dundy County. Buffalo, deer, coyote, prairie chicken, badger, and jackrabbit were most prevalent. Early settlers would have had an even more harsh life had it not been for the venison, smoked fish, and the buckskin and buffalo robes that the territory supplied. The kinds of wildlife varied, then as now, according to the habitat—the sandhills, tablelands, rolling hills, and steep canyons.

Grasslands are the abode for the meadowlark, horned lark, lark bunting, shrikes, and many other birds that eat insects and weed seeds. In the farmyard trees and other woody plantings there are other kinds of birds. Lack of woody cover in large areas keeps many migratory song and insectivorous birds moving across the county in search of nesting places, food, and water.

The most important game bird in the uplands is the ringneck pheasant. The bobwhite quail is another important resident. These birds are in all places where appropriate food and cover exists, but mostly in cultivated areas.

Although not natural residents, ducks, geese, and other migratory fowl provide fall hunting as they stop, rest, and feed during their long journey south.

Bluegill, bass, bullheads, crappies, and other warm-water fish are in the streams and lakes. The total pounds and the value of meat taken from some man-made ponds and lakes exceeds the return per acre obtained when the area was used as agricultural land.

Beavers, muskrats, and bullfrogs are found in the streams and ponds.

Deer provide limited fall hunting in the steep canyons and wooded lowlands along the Republican River. A few red squirrels live among the trees along the lowlands; they can be hunted for a short time in the fall. More common in the open country are the jackrabbit, skunk, ground squirrel, prairie dog, field mouse, and coyote. The coyote has learned to live with man throughout the county. Although the coyote is not too highly respected, he is valuable in controlling jackrabbits, field mice, and other destructive rodents.

Conservation of wildlife on farms

Since wildlife is produced on lands owned privately and used primarily for crops, livestock, or wood, the success of wildlife production depends on how farmers and ranchers use and treat their land.

Almost every practice that helps to protect and improve soil and to conserve moisture also improves food and cover for wildlife. Improved grass on rangeland and pastureland, crop stubble, grass edges along waterways, and windbreaks or shelterbelts aid wildlife directly and, further, are the basic measures for conserving soil and water. Where land use and vegetation alone are not enough to control erosion, small dams, rightly placed and built, are needed. These provide water and cover for wildlife.

There are small, odd-shaped or isolated areas in all land classes that are ideal for development as nesting sites and cover for wildlife. These areas include blow-outs, borrow pits, abandoned roads, small areas isolated by ditches, streams, and gullies, and others not suitable for crops or pasture. Such areas can be fenced to protect them from grazing, or left undisturbed if they are in fields that are cultivated. In areas selected as habitats, burning is controlled and, where necessary, trees, shrubs, and other plants that provide food and cover are planted.

Plantings for wildlife habitats

Plantings for wildlife habitats will depend on the nature of the site and the wildlife desired. In some instances plantings of shrubs and trees are needed. Among the shrubs suited to all areas are American plum, sand cherry, quailbush (three-leaved sumac or skunkbush), cotoneaster, Tartarian honeysuckle, and common lilac. The trees suitable for all sites are redcedar, Russian-olive, honeylocust, ponderosa pine, Austrian pine, hackberry, black locust, boxelder, and green ash.

Shrubs suitable for only some sites are western chokecherry, crabapple, gooseberry, buffaloberry, currant, trailing raspberry, purple willow, and red-osier dogwood. Trees appropriate for only some sites are American elm, cottonwood, and black walnut. Table 4, in the section "Woodland and Windbreaks," can be used as a guide in selecting sites for the different shrubs and trees suitable for wildlife, and the practices of management outlined in that section can be followed. Some proposed wildlife areas will be too steep for cultivation and plant-

ing will need to be done by hand. Redcedar is the best for such areas.

In grassed areas not disturbed by grazing or cultivation, planting of large-seeded legumes with grass will provide food for ground-nesting birds.

Engineering Properties of Soils³

This soil survey report contains information that can be used by engineers to—

1. Make soil and land use studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational use.
2. Make more accurate estimates of runoff and erosion for use in designing drainage structures and in planning dams and other structures for water and soil conservation.
3. Make reconnaissance surveys of soil and ground conditions that will aid in selecting locations for highways and airports and in planning detailed studies of the soils at the intended locations.
4. Estimate drainage areas and runoff characteristics for culvert and bridge design.
5. Classify the soils along proposed highway routes and use this information to make preliminary estimates of required thickness of flexible pavement.
6. Estimate the need for clay to stabilize the surfacing on roads that are not paved.
7. Locate deposits of sand, gravel, rock, mineral filler, and soil binder for use in constructing subbase courses, base courses, and surface courses for flexible pavements for highways and structures.
8. Estimate conditions of terrain, such as topography,

surface drainage, subsurface drainage, and height of the water table, in connection with the design of highway embankments, subgrades, and pavements, both rigid and flexible.

9. Correlate structural performance with types of soil and thus develop information that will be useful in designing and maintaining the structures.
10. Determine the suitability of the soil units for cross-country movement of vehicles and construction equipment.
11. Supplement information obtained from other published maps and reports and aerial photographs, for the purpose of making soil maps and reports that can be readily used by engineers.

The soil map and descriptive report are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Some of the terms used by soil scientists may be unfamiliar to the engineer, and some words—for example, *soil*, *clay*, *silt*, *sand*, *aggregate*, and *granular*—have special meanings in soil science. Most of these terms, as well as other special terms that are used in this section and in the rest of the soil survey report, are defined in the Glossary at the back of this report.

Soil test data and engineering soil classification

In this subsection test data for some of the soils are presented, and the AASHTO and Unified systems of soil classification used in engineering are explained. Additional information about soils can be obtained in the section "Descriptions of Soils" and the section "Soil Formation and Classification."

SOIL TEST DATA

Shown in table 5 are the results of tests on 3 different soil types sampled at 10 sites by the Soil Conservation

TABLE 5.—Engineering test data¹ for soil samples

[Dashes indicate information is not

Soil name and location	Parent or underlying material	Bureau of Public Roads or Nebraska Dept. of Roads report number	Depth	Horizon	Moisture-density	
					Maximum dry density	Optimum moisture
Anselmo loamy fine sand, 0 to 3 percent slopes: 0.35 mile N. and 135 feet W. of SE. corner of sec. 19, T. 2 N., R. 40 W.	Mixed eolian sands, silts, and clays.	S32688	<i>Inches</i> 0-6	A _p -----	<i>Lb. per cu. ft.</i> 114	<i>Percent</i> 12
		S32689	27-36	B ₂₂ -----	116	12
		S32690	44-60	C-----	113	13
0.25 mile W. and 285 feet S. of NE. corner of sec. 17, T. 2 N., R. 40 W.	Mixed eolian sands, silts, and clays.	S32691	0-7	A _p -----	115	12
		S32692	20-28	B ₂₁ -----	120	12
		S32693	41-60	C-----	114	13
Anselmo fine sandy loam, 5 to 9 percent slopes, eroded: ⁶ 3,525 feet W. and 1,625 feet N. of SE. corner of sec. 20, T. 1 N., R. 41 W.	Eolian sands and silts.	S601378	0-72	Upper layer-----	-----	-----
		S601379	72-156	Middle layer-----	-----	-----
		S601391	156-180	Lower layer-----	-----	-----
2,440 feet W. and 100 feet N. of SE. corner of sec. 19, T. 1 N., R. 41 W.	Eolian sands and silts.	S594857	0-18	Upper layer-----	-----	-----
		S594826	18-66	Lower layer-----	-----	-----

See footnotes at end of table.

³ This section was prepared in part by W. J. Ramsey, Division of Materials and Tests, Nebraska Department of Roads, and in part by L. E. Smedley, Soil Conservation Service. The work performed by the Department of Roads was performed under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

Service, as well as results obtained by the Division of Materials and Tests, Nebraska Department of Roads, on 7 different soil types and an area of Sandy alluvial land, at a total of 13 sampling sites. All of these tests were made according to standard procedures of the American Association of State Highway Officials (AASHO). The samples from the 13 sites were obtained and tested during soil surveys made for highway projects located in the county.

Each soil was sampled by natural horizons. The terminology for designating layers, or horizons, is not uniform in table 5 because the Nebraska Department of Roads uses *upper*, *middle*, and *lower* for horizon designations, instead of the "A, B, C" symbols used by many soil scientists. For practical purposes, a layer "A" in the soil scientist's notation is equivalent to *upper*; "B" *middle*, and "C" *lower*. Further explanation of the meaning of horizon symbols generally used by soil scientists can be found in the Glossary of this report.

The soils listed in table 5 were sampled in one or more locations. The test data for a soil sampled in only one location indicate the engineering characteristics of the soil at that location. At locations other than the one where it was sampled, a soil may be considerably different in characteristics that affect its use in engineering. Even for those soils sampled in more than one location, the test data probably do not show the maximum range in characteristics of materials.

Table 5 gives moisture-density, or compaction, data for a number of the soils tested. If a soil material is compacted at progressively higher moisture content, assuming the compactive force remains constant, the density of the compacted material will increase until the optimum moisture content is reached; after that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed maximum dry density. Moisture-density data are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted to about the maxi-

mum dry density when it is at approximately the optimum moisture content.

The engineering soil classifications in the last two columns in table 5 are based on data obtained by mechanical analysis and by tests to determine liquid limits and plastic limits. The mechanical analysis data for each soil sample identified in table 5 were obtained by a combination of sieve and hydrometer analyses. Percentages of clay obtained by the hydrometer method should not be used in naming the textural classes of soils.

The tests for liquid limit measure the effects of water on the consistence of the soil material. As the moisture content of a clay soil increases from a very dry state, the material changes from a solid to a semisolid or plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

ENGINEERING CLASSIFICATION OF SOILS

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (1). In this system soil materials are classified in seven principal groups. The groups range from A-1, consisting of gravelly soils of high bearing capacity, to A-7, consisting of clay soils that have low strength when wet.

Within each of the principal groups, the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column of table 5.

taken from 22 soil profiles, Dundy County, Nebr.

available or not applicable]

Mechanical analysis ²							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—			Percentage smaller than—						AASHO ³	Unified ⁴
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	93	23	12	9	6	6	(⁵)	(⁵)	A 2-4(0)---	SM.
100	95	33	19	15	13	11	(⁵) 22	(⁵) 3	A-2-4(0)---	SM.
100	95	31	14	11	10	8	(⁵)	(⁵)	A-2-4(0)---	SM.
100	90	19	11	9	7	6	(⁵)	(⁵)	A-2-4(0)---	SM.
100	96	33	21	16	13	12	(⁵) 20	(⁵) 3	A-2-4(0)---	SM.
100	99	27	16	12	9	7	(⁵)	(⁵)	A-2 4(0)---	SM.
98	91	58	-----	-----	22	-----	22	6	A-4(5)-----	CL-ML.
99	73	48	-----	-----	20	-----	29	14	A-6(4)-----	SC.
78	26	12	-----	-----	5	-----	19	4	A-1-b(0)---	SM-SC.
100	86	24	14	-----	6	-----	(⁵)	(⁵)	A-2-4(0)---	SM.
100	87	19	10	-----	4	-----	(⁵)	(⁵)	A-2-4(0)---	SM.

TABLE 5.—*Engineering test data*¹ for soil samples taken

Dashes indicate information is not

Soil name and location	Parent or underlying material	Bureau of Public Roads or Nebraska Dept. of Roads report number	Depth	Horizon	Moisture-density	
					Maximum dry density	Optimum moisture
Bridgeport loam, 0 to 1 percent slopes: 0.1 mile S. and 0.4 mile W. of NE. corner of sec. 29, T. 1 N., R. 39 W.	Alluvium on a foot slope.	S32712 S32713 S32714	<i>Inches</i> 0-6 26-42 42-60	A _p ----- C ₂ ----- A _{1b} -----	<i>Lb. per cu. ft.</i> 109 112 112	<i>Percent</i> 17 16 16
2,555 feet W. of NE. corner of sec. 33, T. 1 N., R. 41 W.	Alluvium on a foot slope.	S32715 S32716 S32717	0-7 19-34 48-60	A _p ----- C ₁ ----- C ₃ -----	116 112 112	13 16 16
Bridgeport loam, 1 to 3 percent slopes: 0.25 mile N. and 0.1 mile E. of SW. corner of sec. 36, T. 2 N., R. 37 W.	Alluvium on a foot slope.	S32694 S32695 S32696	0-5 11-23 35-47	A _p ----- C ₁ ----- A _{11b} -----	108 110 110	16 16 15
2,300 feet E. and 45 feet N. of SW. corner of sec. 30, T. 2 N., R. 36 W.	Alluvium on a foot slope.	S32697 S32698 S32699	0-5 13-21 34-42	A _p ----- A _{b1} ----- A _{b2} -----	109 112 110	16 16 16
595 feet S. and 330 feet W. of NE. corner of sec. 24, T. 1 N., R. 42 W.	Alluvium on a foot slope.	S32706 S32707 S32708	0-8 8-16 28-39	A _p ----- B ₁ ----- C ₁ -----	115 115 116	14 15 16
2,375 feet S. and 0.1 mile W. of NE. corner of sec. 14, T. 1 N., R. 42 W.	Alluvium on a foot slope.	S32709 S32710 S32711	0-9 9-15 28-37	A _p ----- B ₁ ----- C ₁ -----	114 113 110	14 16 18
Colby loam, 9 to 30 percent slopes: 1,410 feet S. and 1,015 feet E. of NW. corner of sec. 24, T. 1 N., R. 42 W.	Peorian loess-----	S594853 S594865	0-18 18-48	Upper layer----- Lower layer-----	----- -----	----- -----
Dunday loamy fine sand: 750 feet S. and 60 feet W. of NE. corner of sec. 6, T. 2 N., R. 37 W.	Eolian sands-----	S541680 S541681	0-18 18-72	Upper layer----- Lower layer-----	----- -----	----- -----
Elsmere fine sandy loam, 0 to 1 percent slopes: 1,650 feet S. and 60 feet W. of NE. corner of sec. 6, T. 2 N., R. 37 W.	Eolian sands-----	S541677 S541678	0-30 30-60	Upper layer----- Lower layer-----	----- -----	----- -----
Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes: 250 feet S. and 1,740 feet E. of NW. corner of sec. 31, T. 4 N., R. 39 W.	Tertiary material that resembles loess.	S32700 S32701 S32702	0-6 10-19 34-47	A _p ----- B ₂ ----- D ₂ -----	116 114 112	11 16 16
125 feet S. and 0.15 mile E. of NW. corner of sec. 10, T. 3 N., R. 38 W.	Tertiary material that resembles loess.	S32703 S32704 S32705	0-5 10-18 42-60	A _p ----- B ₂ ----- C _b -----	118 115 111	13 14 16
Keith silt loam, thick, 0 to 1 percent slopes: 2,150 feet N. and 40 feet E. of SW. corner of sec. 8, T. 1 N., R. 37 W.	Peorian loess-----	S471695 S471696	0-18 18-42	Upper layer----- Lower layer-----	----- -----	----- -----
Sandy alluvial land: 2,630 feet S. and 2,560 feet E. of NW. corner of sec. 29, T. 1 N., R. 41 W.	Alluvial sands-----	S594860 S594836	0-8 8-54	Upper layer----- Lower layer-----	113 109	11.5 8.0
Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded: 2,440 feet W. and 890 feet N. of SE. corner of sec. 14, T. 1 N., R. 42 W.	Pierre shale-----	S594870	0-118	Pierre shale-----	-----	-----
Valentine fine sand, rolling: 60 feet W. and 4,650 feet S. of NE. corner of sec. 6, T. 2 N., R. 37 W.	Eolian sands-----	S541665 S541666	0-36 36-118	Upper layer----- Lower layer-----	----- -----	----- -----
120 feet S. and 30 feet W. of NE. corner of sec. 18, T. 3 N., R. 37 W.	Eolian sands-----	S541710 S541711	0-11 11-144	Upper layer----- Lower layer-----	----- -----	----- -----

See footnotes at end of table.

from 22 soil profiles, Dundy County, Nebr.—Continued

available or not applicable]

Mechanical analysis ²							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—			Percentage smaller than—						AASHO ³	Unified ⁴
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
	100	92	77	42	24	20	31	9	A-4(8)-----	ML-CL.
	100	93	72	38	25	20	28	7	A-4(8)-----	ML-CL.
	100	92	69	33	23	19	27	6	A-4(8)-----	CL-ML.
100	98	71	54	29	18	15	23	4	A-4(7)-----	CL-ML.
	100	92	80	48	27	21	30	9	A-4(8)-----	ML-CL.
	100	92	78	44	26	21	28	7	A-4(8)-----	ML-CL.
	100	90	67	31	18	14	28	5	A-4(8)-----	ML-CL.
	100	88	64	26	15	13	26	2	A-4(8)-----	ML.
	100	88	62	29	17	15	26	3	A-4(8)-----	ML.
	100	93	77	37	22	18	27	4	A-4(8)-----	ML-CL.
	100	88	68	35	21	17	28	6	A-4(8)-----	ML-CL.
	100	90	68	30	14	10	28	5	A-4(8)-----	ML-CL.
100	96	62	47	31	20	18	26	8	A-4(5)-----	CL.
100	96	64	53	37	27	22	29	12	A-6(7)-----	CL.
100	98	78	66	47	33	28	31	13	A-6(9)-----	CL.
100	97	67	51	32	21	19	27	9	A-4(6)-----	CL.
100	98	74	59	39	28	25	31	13	A-6(9)-----	CL.
	100	93	82	56	40	32	37	16	A-6(10)-----	CL.
100	99	73	40		13		26	4	A-4(8)-----	ML-CL.
	100	78	41		13		24	3	A-4(8)-----	ML.
100	99	28	11		4		(5)	(5)	A-2-4(0)---	SM.
100	99	35	11		6		(5)	(5)	A-2-4(0)---	SM.
100	96	41	16		5		(5)	(5)	A-4(1)-----	SM.
100	95	29	13		9		(5)	(5)	A-2-4(0)---	SM.
100	85	18	11	6	5	3	(5)	(5)	A-2-4(0)---	SM.
100	97	55	43	28	22	19	32	13	A-6(5)-----	CL.
100	99	80	54	30	20	15	29	8	A-4(8)-----	ML-CL.
100	96	42	27	16	13	11	21	3	A-4(1)-----	SM.
100	99	57	37	24	17	16	27	6	A-4(4)-----	CL-ML.
	100	79	50	25	16	12	27	5	A-4(8)-----	ML-CL.
100	99	79	47		11		26	6	A-4(8)-----	CL-ML.
100	98	76	48		14		27	7	A-4(8)-----	CL-ML.
100	90	23	13		3		(5)	(5)	A-2-4(0)---	SM.
100	91	13	5		1		(5)	(5)	A-2-4(0)---	SM.
100	99	98	92		53		58	32	A-7-6(20)---	CH.
100	96	20	10		5		(5)	(5)	A-2-4(0)---	SM.
100	94	20	12		6		(5)	(5)	A-2-4(0)---	SM.
100	92	17	8		5		(5)	(5)	A-2-4(0)---	SM.
100	94	11	5		4		(5)	(5)	A-2-4(0)---	SM-SP.

TABLE 5.—*Engineering test data*¹ for soil samples taken

[Dashes indicate information is not

Soil name and location	Parent or underlying material	Bureau of Public Roads or Nebraska Dept. of Roads report number	Depth	Horizon	Moisture-density	
					Maximum dry density	Optimum moisture
Valentine loamy fine sand: 2,475 feet N. and 30 feet W. of SE. corner of sec. 18, T. 3 N., R. 37 W.	Eolian sands-----	S541708 S541709	<i>Inches</i> 0-12 12-118	Upper layer----- Lower layer-----	----- -----	----- -----
550 feet S. and 60 feet W. of NW. corner of sec. 5, T. 2 N., R. 37 W.	Eolian sands-----	S541684 S541685	0-18 18-84	Upper layer----- Lower layer-----	----- -----	----- -----

¹ Tests performed by the Bureau of Public Roads and Division of Materials and Tests, Nebraska Department of Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHTO). Sample numbers in the range S32688 to S32717 were tested by the Bureau of Public Roads; the other samples were tested by the Nebraska Department of Roads.

² Mechanical analysis according to the AASHTO Designation: T 88. Results obtained by this procedure frequently differ some-

what from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size

Some engineers prefer to use the Unified Soil Classification system (14). In this system the soils are identified according to their texture and plasticity and are grouped according to their performance as engineering construction materials. The system establishes 15 soil groups, which are divided as (1) coarse-grained soils (eight classes), (2) fine-grained soils (six classes), and (3) highly organic soils. Boundary classifications are provided for soils that have characteristics of two groups.

The Unified system provides for a simple field method for determining the amount and type of the basic constituents of the soils, and it also provides a laboratory method. Both methods are based on gradation and plasticity and vary only in degree of accuracy. In the laboratory method, mechanical analyses and data showing the liquid limit and plasticity index are used to make an exact classification. A plasticity chart on which the liquid limit and the plasticity index can be plotted is used for classifying the fine-grained component of the silty and clayey sands and gravels. The classification of the tested soils according to the Unified system is given in the last column of table 5.

Soil engineering interpretations

The test data in table 5, supported by information in the rest of the report and by experience with the same soils in other counties, were used in preparing tables 6 through 9. Thus, tables 6 and 7 are based on test data, but tables 8 and 9 are not. Table 8 gives, for soils not tested, some characteristics significant in engineering, and table 9 shows the name of each soil not tested, gives the name of the tested soil that it closely resembles, and provides remarks on the characteristics of the soil that affect engineering.

Table 6 gives, for the soils actually tested, soil characteristics and engineering classifications, as well as esti-

mates of those properties that affect use in engineering.

The texture, or grain size, of the alluvial materials varies considerably. Consequently, it should not be assumed that the engineering classifications given in table 6 will apply to all parts, or layers, of an alluvial soil, or that an alluvial soil will be the same wherever it occurs. If engineering structures are to be built on alluvial (water-laid) soils, special field studies should be made at the site to obtain the specific engineering class of the materials accurately.

In table 6, "Permeability" refers to the rate of movement of water through the soil material in its undisturbed state. Permeability depends largely upon the soil texture and structure.

"Available moisture capacity," expressed in inches of moisture per foot of soil depth, is the water available for plants. It is the water held in the range between field capacity and the wilting point.

Shrink-swell potential was not rated in table 6 because all the soils except the Ulysses have low potential change in volume with change in moisture content. The Ulysses soils have a high shrink-swell potential.

Shrink-swell potential is estimated primarily on basis of the amount and type of clay in the soil material. Generally, soils classified as CH and A-7 have a high shrink-swell potential. The clean sands and gravel, the sands and gravel containing small amounts of nonplastic to slightly plastic fines, and the other soil materials that are nonplastic to slightly plastic have low shrink-swell potential.

Table 7 has several columns in which are given ratings or comments indicating suitability of the soil material when used for different engineering purposes. Some of these columns need explanation.

Susceptibility to frost action is a minor engineering problem in Dundy County, but the susceptibility varies

from 22 soil profiles, Dundy County, Nebr.—Continued

available or not applicable]

Mechanical analysis ²							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—			Percentage smaller than—						AASHO ³	Unified ⁴
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	95	16	9	-----	5	-----	(5)	(5)	A-2-4(0)---	SM.
100	93	10	5	-----	4	-----	(5)	(5)	A-2-4(0)---	SM-SP.
100	99	39	18	-----	7	-----	(5)	(5)	A-4(1)-----	SM.
100	98	28	12	-----	7	-----	(5)	(5)	A-2-4(0)---	SM.

fractions. The mechanical analyses used in this table are not suitable for use in naming the textural classes of soils. The percentages of particles smaller than 0.02 millimeter and 0.002 millimeter in size were not determined by the Nebraska Department of Roads.

² Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, ed. 7); The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145-49(1).

⁴ Based on the Unified Soil Classification system. Tech. Memo, 3-357, v. 1, Waterways Experiment Station, Corps of Engineers. March 1953 (14).

⁵ Nonplastic.

⁶ In this soil 100 percent of the upper and middle layers, and 99 percent of the lower layer passes a No. 4 sieve.

among the soils. In general, if a soil is to be rated as not susceptible to frost action, less than 10 percent of its material should pass through a No. 200 sieve. As a rule, soils that contain a large amount of silt and clay are more susceptible to softening by frost action than soils that contain coarser textured materials. Other factors, however, such as the permeability of the underlying material, height of the water table, temperature, and drainage, all influence susceptibility to frost action.

In the two columns under the heading "Subgrade" the soils have been rated as to their suitability if used in the upper part of a subgrade that is to be used for "Paved road" and "Gravel road."

In the column titled "Paved road" are ratings showing suitability of soil material if used as subgrade for either bituminous or concrete pavement. Since sand is the best subgrade for pavements of this type, soil materials are rated "good" if their AASHO classification is A-1, A-2, or A-3. For silt and clay materials, the rating is "fair" or "poor," as the AASHO classification for such materials ranges from A-4 to A-7-6.

The ratings in the column titled "Gravel road" are for materials used in that part of the subgrade receiving a gravel surfacing. Since sand is noncohesive, it does not provide a stable surface on which to place gravel. Thus, all soils with an AASHO rating of A-3 are "poor," as are also those in the A-1 and A-2 groups that do not have adequate plasticity. Some soil materials that are in the A-1 and A-2 groups, and that also have adequate plasticity, may be rated "good" or "fair." Also, silt or clay soil materials with an AASHO classification of A-4 to A-7-6 are normally acceptable in that part of the upper subgrade receiving a gravel surfacing, and these materials are rated "good" or "fair."

The ratings in the column "Road fill" are based on the same criteria as those used for rating subgrade for bitu-

minous or concrete pavement. In this column, as well as in those titled "Paved road" and "Gravel road," the ratings may show a range; for example, "good to fair," or "good to poor." This spread indicates the variation of the material in the soil profile.

No rating on suitability of the soil materials for winter grading is provided in table 7, but the following comments are pertinent.

Whether or not a soil material can be graded in winter depends on the content of moisture and the temperature. Sometimes there is little moisture during the winter, and no frost forms in the soil. Then, if the temperature is high enough, moisture can be added so that the soil will be suitable for grading and compaction. In contrast, during a winter when there is a large amount of moisture in the soil and the temperature remains below freezing for long periods, winter grading, earth movement, and compaction will be stopped or will be difficult to perform.

In general, gravelly or sandy soil material that contains only a small amount of silt or clay is better for winter grading than soil material that has a high proportion of silt and clay. Grading should be allowed in the gravelly or sandy soil material only if required standards of construction, with respect to compaction of the soils, are maintained and frozen materials are excluded.

The ratings given the soils as a source of topsoil or as a source of sand and gravel apply only to the soils tested in Dundy County. Several of the soils are rated "poor" as a source of topsoil because the soil material is too sandy to contain a large amount of plant nutrients. Some of the soils are rated "good" as a source of sand and gravel. Although a soil has a rating of "good" as a source of sand and gravel, extensive exploration may be necessary to find material that will meet gradation requirements.

The vertical alinement of highways is affected by poor drainage. It is also affected by depth to bedrock and the

TABLE 6.—*Characteristics and engineering classification of the soils tested*

[Dashes indicate information is

Map symbol	Soil	Position	Parent material	Drainage		Depth to bedrock or mixed sand and gravel	Thick-ness of horizons
				Surface runoff	Depth to water table		
AoAW, AoBW...	Anselmo loamy fine sand	Uplands...	Mixed eolian sands, silts, and clays.	Slow.	<i>Feet</i>	<i>Inches</i>	<i>Inches</i> 0-6 27-36 44-60
An, AnA, AnB, AnC, AnC2, AnD.	Anselmo fine sandy loam.	Uplands.....	Eolian sands and silt.....	Slow to medium.			0-18 18-66
Bh, BhA, BhB...	Bridgeport loam.....	Foot slopes.....	Colluvial silts.....	Medium to slow.	10-20		0-5 11-23 35-47
CdCW, CdDW...	Colby loam.....	Uplands.....	Loess.....	Rapid.			0-18 18-48
Du, 2Du.....	Dunday loamy fine sand.	Valleys in the sandhills.	Eolian sands.....	Slow.	8-30		0-18 18-72
Es, EsC.....	Elsmere fine sandy loam.	Valleys in the sandhills.	Eolian sands.....	Slow.	3-8	72+	0-30 30-60
KfAW, 2KfA, KfB2, 2Kf, 4Kf, 4KfW.	Keith fine sandy loam.....	Uplands.....	Loess and eolian sands.....	Slow to medium.			0-5 10-18 42-60
KeAW, 2Ke, 4Ke, 2KeA, KeB2.	Keith silt loam.....	Uplands.....	Loess.....	Medium to slow.			0-18 18-42
Sx.....	Sandy alluvial land.....	Bottom lands...	Alluvial sands.....	Slow.	2-10	10-60	0-7 7-54
2UC2.....	Ulysses loam, clay substratum variant.	Uplands.....	Loess and Pierre shale...	Rapid.		12-72	0-118
2UC3.....	Ulysses clay loam, clay substratum variant.	Uplands.....	Loess and Pierre shale...	Rapid.		12-72	0-118
VaC, VaD.....	Valentine fine sand.....	Uplands.....	Eolian sands.....	Slow.			0-11 11-144
Vb.....	Valentine loamy fine sand.	Uplands.....	Eolian sands.....	Slow.			0-12 12-108

water table. Only relation of water table to vertical alignment is considered in table 7. The soils on bottom lands are likely to be flooded occasionally. Although soils on high bottom lands and on terraces are seldom flooded, structures should be planned that will dispose of runoff water. All of the soils in Dundy County are susceptible to wind erosion if the vegetation is removed.

The compaction characteristics of the soils are rated in table 7 for only that part of the profile normally used in preparing foundations, which excludes the material in the topmost 6 to 12 inches. The ratings apply only to the depths of the profiles as given in table 5. Compaction characteristics are rated as "good" or "poor" on the basis of the workability of the soil with standard compaction equipment.

The soil features listed in table 7 that affect construction of dams, dikes, and other engineering structures are those that normally present problems in construction and maintenance. The features for each soil listed are estimated on basis of the profile described for that soil in table 5. A variation in the soil profile, such as a variation in depth to gravel, will change the ratings for the soil when it is used in some structures.

The effects of salinity and alkalinity have not been rated. Depending on the degree of salinity or alkalinity and the quantity of materials affected, a saline-alkaline condition may seriously affect the piping hazard, internal drainage, and workability of a soil. Also, this condition restricts the use of vegetation in waterways and other structures.

and estimated physical properties that affect their use for engineering purposes

not available or not applicable]

Classification				Percent passing—		Permeability	Available moisture capacity
USDA texture	AASHTO symbol	Unified Symbol	Unified Texture	No. 10 sieve (2.0 mm.)	No. 200 sieve (0.074 mm.)		
Loamy fine sand	A-2-4(0)	SM	Silty sand	100	15-25	<i>Inches per hour</i> 5.0 to 10.0	<i>Inches per foot</i> 1.25
Fine sandy loam	A-2-4(0)	SM	Silty sand	100	25-35	2.5 to 5.0	1.75
Loamy fine sand	A-2-4(0)	SM	Silty sand	100	25-35	5.0 to 10.0	1.75
Fine sandy loam	A-2-4(0)	SM	Silty sand	100	25-50	2.5 to 5.0	1.75
Fine sandy loam	A-2-4(0)	SM	Silty sand	100	10-20	2.5 to 5.0	1.75
Loam	A-4(8)	ML	Clayey silt	100	60-95	0.8 to 2.5	2.0
Loam	A-4(8)	ML	Clayey silt	100	65-95	0.8 to 2.5	2.0
Loam	A-4(8)	ML	Clayey silt	100	75-96	0.8 to 2.5	2.0
Loam	A-4(8)	ML	Sandy silt	100	70-75	0.8 to 2.5	2.0
Loam	A-4(8)	ML	Sandy silt	100	75-80	0.8 to 2.5	1.8
Loamy fine sand	A-2-4(0)	SM	Silty sand	100	35-40	5.0 to 10.0	1.25
Loamy fine sand	A-2-4(0)	SM	Silty sand	100	30-40	5.0 to 10.0	1.25 to 0.75
Loamy fine sand	A-4(1)	SM	Silty sand	100	35-45	2.5 to 5.0	1.75
Loamy fine sand	A-2-4(0)	SM	Silty sand	100	25-35	2.5 to 5.0	.75
Fine sandy loam	A-4(1)	SM	Silty sand	100	40-45	2.5 to 5.0	1.75
Loam	A-4(4)	CL-ML	Sandy and clayey silt	100	50-60	0.8 to 2.5	2.00
Silt loam	A-4(8)	ML	Clayey silt	100	75-80	0.8 to 2.5	2.00
Silt loam	A-4(8)	CL-ML	Clayey silt	100	75-80	0.8 to 2.5	2.00
Silt loam	A-4(8)	CL-ML	Clayey silt	100	75-80	0.8 to 2.5	2.00
Sand	A-2-4(0)	SM	Silty sand	100	20-25		1.25
Sand	A-2-4(0)	SM	Silty sand	100	10-20		1.25 to 0.75
Clay	A-7-6(20)	CH	Silty clay	100	90-100	0.2 to 0.8	2.10
Clay	A-7-6(20)	CH	Silty clay	100	90-100	0.2 to 0.8	2.10
Fine sand	A-2-4(0)	SM	Silty sand	100	10-20	5.0 to 10.0	.75
Fine sand	A-2-4(0)	SP-SM	Silty sand	100	10-15	5.0 to 10.0	.75
Fine loamy sand	A-2-4(0)	SM	Silty sand	100	15-40	5.0 to 10.0	1.25
Fine sand	A-2-4(0)	SP-SM	Silty sand	100	10-30	5.0 to 10.0	1.25 to 0.75

The bearing capacity and piping hazard of the soils have been rated for foundations. These ratings are for soils used in the foundations of concrete structures and small dams. They apply to the depths given in the profiles described in table 5.

In the column for low dams, are given the soil features that affect construction of the reservoir area and embankments for small earthen dams.

These data may serve as a guide for the preliminary design of larger structures that require grade stabilization, such as irrigation structures and structures to control floodwaters. For these large structures, however, a detailed geologic investigation should be made at the site.

In judging the suitability of the soils for dikes or levees, only suitability for relatively low dikes and levees was considered. The information given is for the material in 30 inches of the profile. This information should help in the preliminary planning for large dikes and levees, but for these large structures, a detailed investigation at the site should be made.

For agricultural drainage, the rate of permeability and the condition of the surface are stated, where applicable. For the Elsmere fine sandy loams, a rating of moderately rapid permeability is given, based on the penetration of moisture at the rate of 2.5 to 5.0 inches per hour.

Under irrigation, the water-holding capacity is given and the water intake is rated for some of the soils. Irrigation hazards related to slope are not shown.

TABLE 7.—*Engineering*

[Dashes indicate information

Map symbol	Soil	Suscepti- bility to frost action	Suitability of soil material as—			Suitability as source of—		Compaction characteristics
			Subgrade		Road fill	Topsoil	Sand and gravel	
			Paved road	Gravel road				
An, AnA, AnB, AnC, AnC2, AnD.	Anselmo fine sandy loam.	Moderate..	Good to fair.	Poor to fair.	Good to fair.	Fair....	Good to poor for fine sand.	Good, with close moisture control.
AoAW, AoBW..	Anselmo loamy fine sand.	Moderate..	Good to fair.	Poor to fair.	Good to fair.	Poor....	Good to poor for fine sand.	Good, with close moisture control.
Bh, BhA, BhB..	Bridgeport loam.....	High.....	Fair to poor.	Good....	Fair to poor.	Good to fair.	Poor.....	Good to poor; will require close moisture control.
CdCW, CdDW..	Colby loam.....	High.....	Fair to poor.	Good....	Fair to poor.	Good to fair.	Poor.....	Good to poor; will require close moisture control.
Du, 2Du.....	Dunday loamy fine sand..	Moderate..	Good to fair.	Fair to poor.	Good to fair.	Poor....	Good to poor for fine sand.	Fair to good with close moisture control.
Es, EsC.....	Elsmere fine sandy loam..	Moderate..	Good to fair.	Fair to poor.	Good to fair.	Fair....	Good for sand..	Moderate to high piping hazard; may require flat slopes.
KfAW, 2KfA, KfB2, 2Kf, 4Kf, 4KfW.	Keith fine sandy loam....	High.....	Fair to poor.	Good to fair.	Fair to poor.	Fair....	Poor.....	Fairly good; may require some flatten- ing of slopes.
KeAW, 2Ke, 4Ke, 2KeA, KeB2.	Keith silt loam.....	High.....	Fair to poor.	Good....	Fair to poor.	Good....		Fair; slopes may need to be flattened.

See footnotes at end of table.

interpretations for soils tested

not available or not applicable]

Water table and vertical alinement of highways	Features affecting construction of—						
	Foundations	Low dams		Dikes or levees	Agricultural drainage systems	Irrigation systems	Terraces and waterways
		Reservoir area	Use for embankments				
No problem.....	Good to poor bearing capacity, depending on density; moderate to high piping hazard.	Moderate to high seepage.	Fairly stable; fairly impervious.	Moderate to high piping hazard; may require flat slopes.	(1).....	Moderate water-holding capacity.	Highly susceptible to erosion by wind and water; maintenance may be a problem.
No problem.....	Good to poor bearing capacity; moderate to high piping hazard.	Moderate seepage.	Fairly stable; impervious.	May require flat slopes or protection of slopes.	(1).....	Moderate water-holding capacity.	Highly susceptible to erosion by wind and water; construction and maintenance may be a problem.
No problem.....	Very poor to fair bearing capacity; moderate piping hazard.	Seepage not a problem.	Fair to poor stability; will probably require toe drains.	Moderate piping hazard; may require protection of slopes.	(1).....	High water-holding capacity.	Moderately susceptible to erosion.
No problem.....	Very poor to fair bearing capacity; high to moderate piping hazard.	Low seepage.	Poor stability; toe drains probably required.	High to moderate piping hazard; may require flat slopes or protection of slopes.	(1).....	Moderate to high water-holding capacity.	Highly susceptible to erosion by wind and water; the costs of construction and maintenance may be excessive.
No problem.....	Good to poor bearing capacity; moderate piping hazard.	Moderate to high seepage.	Fairly stable; fairly impervious; may require toe drains.	Moderate piping hazard; protection of slopes may be required.	(1).....	Low water-holding capacity.	Highly susceptible to erosion; the costs of construction and maintenance may be excessive.
May rise to 3 feet of the surface; 4 to 7 feet of fill may be required.	Good to poor bearing capacity; moderate piping hazard.	Moderate seepage.	Fairly stable; fairly impervious; may require toe drains.	Good to fair with close moisture control.	(2).....	Low water-holding capacity; adequate drainage necessary.	(1).
No problem.....	Fair to poor bearing capacity; moderate piping hazard.	Low seepage hazard.	Fair to poor stability; impervious; may require toe drains.	Good to poor with close moisture control.	(1).....	Moderate to high water-holding capacity.	Moderately susceptible to erosion.
No problem.....	Fair to good bearing capacity; moderate piping hazard.	Seepage not a problem.	Fair to good stability; impervious; may require toe drains.	Fair; close moisture control needed.	(1).....	High water-holding capacity.	Moderately susceptible to erosion.

TABLE 7.—*Engineering interpretations*

[Dashes indicate information

Map symbol	Soil	Susceptibility to frost action	Suitability of soil material as—			Suitability as source of—		Compaction characteristics
			Subgrade		Road fill	Topsoil	Sand and gravel	
			Paved road	Gravel road				
Sx-----	Sandy alluvial land-----	Moderate..	Variable..	Variable..	Variable..	Poor----	Good for sand--	Variable-----
2UC2-----	Ulysses loam, clay substratum variant.	High-----	Poor----	Good to fair.	Poor----	Poor----	-----	May require protection of slopes.
2UC3-----	Ulysses clay loam, clay substratum variant.	High-----	Poor----	Good to fair.	Poor----	Poor----	-----	May require protection of slopes.
VaC, VaD----	Valentine fine sand (surface).	Moderate..	Good----	Poor----	Good----	Poor----	Good for fine sand.	Fair; moderate piping hazard; may need to flatten slopes.
Vb-----	Valentine loamy fine sand (surface).	Moderate..	Good----	Poor----	Good----	Poor----	Good for fine sand.	Fair; moderate piping hazard; may need to flatten slopes.

¹ Because of position, topography, slope, or characteristics of the soil, this practice is generally not needed.² Seasonal high water table, moderately rapid permeability.³ Subject to infrequent overflow.

The water-holding capacity, stated in relative terms for many of the soils is for the top 4 feet of the soil profile. The terms are defined thus:

Rating:	Water-holding capacity
High-----	More than 8 inches.
Moderate-----	5 to 8 inches.
Low-----	3 to 5 inches.
Very low-----	Less than 3 inches.

The intake of water is described as "rapid," "moderate," or "slow." A "slow" intake rate is less than one-half inch per hour, and a "rapid" intake rate is 2 inches per hour, or more. A "moderate" intake rate is between these two extremes. For all soils, the intake rate was based on border or sprinkler irrigation with a cover of plants.

In the last column of table 7, the susceptibility of terraces and waterways to erosion is rated. This rating applies to terraces as a whole, and to the slopes and channels of waterways. Hummocky topography may limit the use of terraces. On the other hand, terraces are often

constructed to conserve water when they are not needed to control erosion. The semiarid climate of Dundy County makes it difficult to establish vegetation unless supplemental water is added.

Planning engineering soil surveys

At many proposed construction sites, major soil variations may occur within the depth of planned excavation. Also, several different soils may need to be excavated within a short distance. For these reasons, the soil maps and profile descriptions elsewhere in this report, with the engineering data and suggestions given in this part, are useful in planning the detailed surveys of soils that are needed at construction sites. By using the information in the soil survey report, the engineer can save considerable time during preliminary investigations and thus concentrate on the most suitable soil units. By so doing, a minimum number of soil samples is required for laboratory testing, and an adequate soil investigation can be made at minimum cost.

for soils tested—Continued

not available or not applicable]

Water table and vertical alinement of highways	Features affecting construction of—						
	Foundations	Low dams		Dikes or levees	Agricultural drainage systems	Irrigation systems	Terraces and waterways
		Reservoir area	Use for embankments				
May rise to 2 feet from the surface; 4 to 7 feet of fill may be required.	Variable.....	Variable.....	Variable.....	Variable.....	(3).....	Low water-holding capacity; high intake rate.	(1).
Water table not a problem; Pierre shale at a depth of 1 to 6 feet.	Fair to poor bearing capacity.	Seepage not a problem.	Fair stability; impervious.	Fair to poor...	(1).....	High water-holding capacity; slow intake rate.	Highly susceptible to erosion; the cost of maintenance may be excessive.
Water table not a problem; Pierre shale at depth of 1 to 6 feet.	Fair to poor bearing capacity.	Seepage not a problem.	Fair stability; impervious.	Fair to poor...	(1).....	High water-holding capacity; slow intake rate.	Highly susceptible to erosion; cost of maintenance may be excessive.
Water table not a problem.	Good to poor bearing capacity; slight piping hazard.	Moderate to high seepage.	Fair stability; impervious to pervious; may require toe drains.	Good.....	(1).....	Low water-holding capacity; high intake rate.	(1).
Water table not a problem.	Good to poor bearing capacity; slight piping hazard.	Moderate to high seepage.	Fair stability; impervious to pervious; may require toe drains.	Good.....	(1).....	Low water-holding capacity; high intake rate.	(1).

Descriptions of Soils

This section is for those who want detailed information about the soil series and mapping units in Dundy County. It describes the soil series, or groups of soils, and the single soils, or mapping units. The descriptions are arranged in alphabetic order, by series name.

An important part of the description for each soil series is the soil profile. This is a record of what the soil scientist saw and learned when he dug into the ground. The profile described for each series is "typical"; that is, average, or modal, for the series. All the soils of one series have essentially the same profile. The differences, if any, are explained in the description of each soil, or are evident in the name of the soil. To illustrate, a detailed profile is described for the Anselmo series, and the reader can assume that the Anselmo soils mapped in Dundy County have essentially this kind of profile.

In describing soils, some technical terms and special methods of recording information are used simply because there seems to be no other practical way to report, accurately and briefly, what readers need to know about soils. Most of these terms are defined in the Glossary at the back of this report.

The letters *A*, *B*, and *C* are used to designate layers, or horizons, in a soil profile. Each letter conveys special meaning, as is explained in the Glossary. Most readers, however, need only to remember that *A* indicates the top layer, or layers, reaching to a depth of 5 to 8 inches; the letter *B*, subsoil layers; and *C* the parent material from which the *A* and *B* layers were formed. The *A*, *B*, and *C* horizons can be divided; for example, *A*₁, *A*₂, and *A*₃.

The thickness of a soil layer varies from place to place. Hence, in the typical profile for each series, the thickness, in inches, that starts the description of each layer is the thickness at the location sampled.

TABLE 8.—*List of soils not tested that have engineering properties similar to those of soils tested*

Symbol on map	Soil	Refer to test data and interpretations for—	Remarks
Bb.....	Banks fine sand.....	Sandy alluvial land.....	Water table no problem in vertical alinement of highways; low water-holding capacity; high intake rate.
Bc.....	Banks loamy fine sand.....	Sandy alluvial land.....	Water table no problem in vertical alinement of highways; low water-holding capacity.
Bf, BfA.....	Bayard fine sandy loam.....	Anselmo fine sandy loam.....	Moderate water-holding capacity; highly susceptible to erosion from wind and water; maintenance may be a problem.
BfA2.....	Bayard loamy fine sand.....	Anselmo loamy fine sand.....	Moderate water-holding capacity; highly susceptible to erosion from wind and water; construction and maintenance may be problems.
B.....	Blown-out land.....	Valentine fine sand.....	Very low water-holding capacity; high intake rate.
Sy.....	Broken alluvial land.....	Bridgeport loam.....	Subject to occasional to frequent overflow; moderate to high water-holding capacity; adequate drainage necessary.
Ga.....	Gannett fine sandy loam.....	Elsmere fine sandy loam.....	Susceptibility to frost action is moderate to high; at times water table rises to surface; may require 4 to 7 feet of fill in vertical alinement of highways; moderate water-holding capacity; adequate drainage necessary.
Gd.....	Glendive fine sandy loam.....	Anselmo fine sandy loam.....	Moderate water-holding capacity; highly susceptible to erosion from wind and water; maintenance may be a problem.
Gf.....	Goshen fine sandy loam.....	Keith fine sandy loam.....	Subject to flooding; moderate to high water-holding capacity; adequate drainage necessary; moderately susceptible to erosion.
Gh.....	Goshen silt loam.....	Keith silt loam.....	Subject to flooding; high water-holding capacity; adequate drainage necessary; slightly susceptible to erosion.
Hf.....	Havre fine sandy loam.....	Keith fine sandy loam.....	Suitability of soil material for road subgrade (paved) is good to fair, and for road subgrade (gravel), fair; for road fill, material is fair to good; suitability as a source of sand and gravel is fair to poor; moderate water-holding capacity; moderately susceptible to erosion.
Hh.....	Havre loam.....	Bridgeport loam.....	Suitability of soil material for road subgrade (paved) is fair to good, and for road subgrade (gravel), fair to poor; for road fill the material is fair to good; suitability as a source of sand and gravel is fair to poor; moderate water-holding capacity; moderately susceptible to erosion.
Ln.....	Las Animas loamy fine sand.....	Elsmere fine sandy loam.....	Poor as a source of topsoil; fair for fine sand; seasonal high water table; rapid permeability; low water-holding capacity; adequate drainage necessary; some problems of salts and alkali.
Ov.....	Ovina fine sandy loam.....	Keith fine sandy loam.....	At times water table rises to within 2 feet of surface; may require 4 to 7 feet of fill in vertical alinement of highways; moderate to high water-holding capacity; adequate drainage necessary; some problems of salts and alkali.
BL.....	Rough broken land, loess.....	Colby loam.....	Drainage not needed.
Sc.....	Scott silt loam.....	Ulysses clay loam, clay substratum variant.	Subject to flooding; may require 4 to 7 feet of fill; slowly permeable and subject to ponding; high water-holding capacity; adequate drainage necessary.
UsC, UsC2.....	Ulysses silt loam.....	Keith silt loam.....	High water-holding capacity; highly susceptible to erosion; construction and maintenance may be problems.
3VfA.....	Vebar fine sandy loam.....	Anselmo fine sandy loam.....	Vertical alinement of highways may be affected in places by rock, which is at a depth of 1½ to 3 feet in places; moderate water-holding capacity; highly susceptible to erosion.

TABLE 9.—*Characteristics significant in engineering for the soils not tested*

Map symbol	Soil	Position	Parent material	Drainage		Depth to bed-rock or sand and gravel	Engineering classification and characteristics are somewhat similar to those of—
				Surface runoff	Depth to water table		
Bb -----	Banks fine sand -----	Bottom lands ---	Alluvial sands -----	Slow -----	<i>Feet</i> 8-15	<i>Feet</i> 36-72	Sandy alluvial land.
Bc -----	Banks loamy fine sand ---	Bottom lands ---	Alluvial sands -----	Slow -----	8-15	36-72	Dunday loamy fine sand.
Bf, BfA ----	Bayard fine sandy loam ---	Foot slopes -----	Eolian and col-luvial sands.	Slow -----	10-20	72+	Anselmo fine sandy loam.
BfA2 -----	Bayard loamy fine sand ---	Foot slopes -----	Alluvial and col-luvial sands.	Slow -----	10-20	72+	Anselmo loamy fine sand.
B -----	Blown-out land -----	Uplands -----	Eolian sands -----	Slow -----			Valentine fine sand.
Sy -----	Broken alluvial land -----	Bottom lands ---	Silty alluvium -----	Slow -----	12-25	72+	Bridgeport loam.
CgB -----	Canyon fine sandy loam ---	Uplands -----	Limy sandstone -----	Medium to rapid.		6-18	(¹).
Ga -----	Gannett fine sandy loam ---	Sandhill swales ---	Eolian sands -----	Slow -----	0-3		Elsmere fine sandy loam.
Gd -----	Glendive fine sandy loam ---	Bottom lands ---	Alluvial sands -----	Slow -----	6-15	48-72	Anselmo fine sandy loam.
Gf -----	Goshen fine sandy loam ---	Upland swales ---	Colluvial sands -----	Slow -----			Keith fine sandy loam.
Gh -----	Goshen silt loam -----	Upland swales ---	Colluvial silts -----	Slow -----			Keith silt loam.
Hf -----	Havre fine sandy loam ---	Bottom lands ---	Alluvial silts and sands.	Slow -----	6-15	36-72	Keith fine sandy loam.
Hh -----	Havre loam -----	Bottom lands ---	Alluvial silts -----	Slow -----	6-15	36-72	Bridgeport loam.
2Ls -----	Las fine sandy loam, saline-alkali.	Bottom lands ---	Alluvial sands and silts.	Slow -----	3 6	24-60	(¹).
2Lt -----	Las loam, saline-alkali ---	Bottom lands ---	Alluvial sands and silts.	Slow -----	3-6	24-60	(¹).
Ln -----	Las Animas loamy fine sand.	Bottom lands ---	Alluvial sands -----	Slow -----	3-6	24-72	Elsmere fine sandy loam.
LS -----	Laurel soils -----	Bottom lands ---	Alluvial silts -----	Slow -----	2-6	36-72	(¹).
Ov -----	Ovina fine sandy loam ---	Valleys in the sandhills.	Eolian sands and silts.	Slow -----	2-6		Keith fine sandy loam.
Pt -----	Platte loam -----	Bottom lands ---	Alluvial sands and gravel.	Slow -----	0-3	8-18	(¹).
Ra -----	Rauville loam -----	Bottom lands ---	Alluvial silts -----	Slow -----	0-3	48-72	(¹).
BCa -----	Rough broken land, caliche.	Uplands -----	Limy sandstone -----	Rapid -----	0-6		(¹).
BL -----	Rough broken land, loess.	Uplands -----	Loess -----	Rapid -----			Colby loam.
Sc -----	Scott silt loam -----	Depressions in the uplands.	Loess -----	Ponded -----			Ulysses clay loam, clay substratum variant.
UsC, UsC2 --	Ulysses silt loam -----	Uplands -----	Loess -----	Medium to rapid.			Keith silt loam.
3VfA -----	Vebar fine sandy loam, moderately deep.	Uplands -----	Eolian sands and limy sandstone.	Slow to medium.		16-36	Anselmo fine sandy loam.

¹ No data available.

The boundaries between horizons are described to indicate their thickness and shape. The terms for thickness are (1) *abrupt*, if less than 1 inch thick; (2) *clear*, if about 1 to 2½ inches thick; (3) *gradual*, if 2½ to 5 inches thick; and (4) *diffuse*, if more than 5 inches thick. The shape of boundaries is described as *smooth*, *wavy*, *irregular*, or *broken*.

Colors of soil layers are given in words and in Munsell notations; for example, "dark grayish brown (10YR 4/2)." The Munsell notations describe color more precisely than can be done in words; they are used mainly by those who need to make close comparisons among soils. In this report, colors are given for the soil when dry and when moist. If the word description of a color is not followed by "when moist," this means that the color is for dry soil.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers and by laboratory analysis.

Structure, or the aggregates in the soil layers, is described to indicate strength or grade (*weak*, *moderate*, or *strong*); size (*very fine*, *fine*, *medium*, *coarse*, or *very coarse*); and shape (*platy*, *prismatic*, *columnar*, *blocky*, *subangular blocky*, *granular*, or *crumb*). Soils without definite structure, or aggregates, are described as *single grain* (sands) or *massive* (clays).

The approximate acreage and proportionate extent of the soils are shown in table 10. Their location and distribution are shown on the soil map at the back of this report. Within some of the soils delineated on the map, there are small areas different from the soil in which they occur. These areas are marked with special symbols, which are explained in the legend for the soil map.

TABLE 10.—*Approximate acreage and proportionate extent of soils mapped*

Map- ping unit	Soil	Acre s	Per- cent	Map- ping unit	Soil	Acre s	Per- cent
An	Anselmo fine sandy loam, 0 to 1 percent slopes	1,799	0.3	KfB2	Keith fine sandy loam, 3 to 5 percent slopes, eroded	2,921	0.5
AnA	Anselmo fine sandy loam, 1 to 3 percent slopes	2,952	.5	4Kf	Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes	1,608	.3
AnB	Anselmo fine sandy loam, 3 to 5 percent slopes	530	.1	4KfW	Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes	4,397	.7
AnC	Anselmo fine sandy loam, 5 to 9 percent slopes	1,083	.2	2Kf	Keith fine sandy loam, thick, 0 to 1 percent slopes	1,725	.3
AnC2	Anselmo fine sandy loam, 5 to 9 percent slopes, eroded	3,295	.6	2KfA	Keith fine sandy loam, thick, 1 to 3 percent slopes	2,482	.4
AnD	Anselmo fine sandy loam, 9 to 30 percent slopes	2,040	.3	KeAW	Keith silt loam, 1 to 3 percent slopes	8,954	1.5
AoAW	Anselmo loamy fine sand, 0 to 3 percent slopes	32,819	5.6	KeB2	Keith silt loam, 3 to 5 percent slopes, eroded	7,818	1.3
AoBW	Anselmo loamy fine sand, 3 to 5 percent slopes	17,524	3.0	4Ke	Keith silt loam, caliche substratum, 0 to 1 percent slopes	1,832	.3
Bb	Banks fine sand	675	.1	2Ke	Keith silt loam, thick, 0 to 1 percent slopes	44,495	7.6
Bc	Banks loamy fine sand	747	.1	2KeA	Keith silt loam, thick, 1 to 3 percent slopes	16,648	2.8
Bf	Bayard fine sandy loam, 0 to 1 percent slopes	632	.1	Ln	Las Animas loamy fine sand	692	.1
BfA	Bayard fine sandy loam, 1 to 3 percent slopes	935	.2	2Ls	Las fine sandy loam, saline-alkali	1,843	.3
BfA2	Bayard loamy fine sand, wind-hummocky	840	.1	2Lt	Las loam, saline-alkali	2,306	.4
B	Blown-out land	6,783	1.2	LS	Laurel soils	825	.1
Bh	Bridgeport loam, 0 to 1 percent slopes	5,182	.9	Ov	Ovina fine sandy loam, 0 to 1 percent slopes	706	.1
BhA	Bridgeport loam, 1 to 3 percent slopes	5,906	1.0	Pt	Platte loam	1,263	.2
BhB	Bridgeport loam, 3 to 5 percent slopes	1,382	.2	Ra	Rauville loam	2,495	.4
Sy	Broken alluvial land	2,472	.4	BCa	Rough broken land, caliche	715	.1
CgB	Canyon fine sandy loam, 3 to 5 percent slopes	540	.1	BL	Rough broken land, loess	18,295	3.1
CdCW	Colby loam, 3 to 9 percent slopes	3,564	.6	Sx	Sandy alluvial land	5,000	.9
CdDW	Colby loam, 9 to 30 percent slopes	47,199	8.0	Sc	Scott silt loam	782	.1
Du	Dunday loamy fine sand	20,113	3.4	2UC2	Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded	2,505	.4
2Du	Dunday loamy fine sand, loam substratum	11,758	2.0	2UC3	Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded	578	.1
Es	Elsmere fine sandy loam, 0 to 1 percent slopes	3,518	.6	UsC	Ulysses silt loam, 5 to 9 percent slopes	4,139	.7
EsC	Elsmere fine sandy loam, 1 to 5 percent slopes	616	.1	UsC2	Ulysses silt loam, 5 to 9 percent slopes, eroded	3,975	.7
Ga	Gannett fine sandy loam	294	.1	VaD	Valentine fine sand, hilly	17,247	2.9
Gd	Glendive fine sandy loam	409	.1	VaC	Valentine fine sand, rolling	204,423	34.7
Gf	Goshen fine sandy loam, 0 to 1 percent slopes	2,312	.4	Vb	Valentine loamy fine sand	34,225	5.8
Gh	Goshen silt loam, 0 to 1 percent slopes	3,877	.7	3VfA	Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes	1,555	.3
Hf	Havre fine sandy loam	1,176	.2		River and river channels	3,200	.5
Hh	Havre loam	2,957	.5		Lakes	310	.1
KfAW	Keith fine sandy loam, 1 to 3 percent slopes	3,437	.6		Intermittent lakes	115	(¹)
					Total	589,440	100.0

¹ Less than 0.1 percent.**Alluvial land**

Alluvial land consists of generally stratified sediments that were recently deposited by rivers or streams. They vary widely in texture and may be changed when streams overflow. There are two kinds of Alluvial land in the county: Sandy alluvial land and Broken alluvial land.

Broken alluvial land (Sy).—This land type consists largely of mixed silty materials deposited on the narrow, nearly level bottom lands along intermittent drainageways or streams that flow through deeply entrenched canyons to the Republican River. Meandering creek channels bordered by abrupt slopes are common.

This land developed in sediments derived mainly from surrounding Colby soils or Rough broken land, loess. It is silty and layered. The sandy layers and clayey layers,

which are not common, come from sandy strata or from clay shale of the raw, broken slopes of the uplands.

Most of this land is in pasture, and western wheatgrass is the dominant grass. A few small, smooth patches not cut by meandering channels are cropped, mainly to alfalfa. Most of the areas otherwise suitable for farming are too small and hard to reach with farming equipment. In areas cultivated, small plants are washed out or covered by the overflow that follows heavy spring rains. Annual weeds are hard to control.

Capability unit VIw-1, dryland; Overflow range site; Moderately Wet woodland site.

Sandy alluvial land (Sx).—This land type is largely sand that exceptionally high floodwaters have dumped along the Republican River and its major tributaries.



Figure 28.—Sandy alluvial land.

Plants are growing in these deposits, but the deposits are too recent for soils to have developed. On the finer textured sandy materials, a 1- to 2-inch, dark surface layer has formed, but on the coarser sand or gravel there is no true soil.

Overall, this land is nearly level, but within short distances it is very irregular because the floodwaters left mounds and channels (fig. 28).

The water table is 2 to 8 feet below the surface. Drainage varies, and shallow holes made by floodwaters are common. This land type includes small areas of the Banks, Las, Las Animas, and Platte soils.

This land type is used for native grass and wooded pasture, for which it is best suited. The vegetation consists of cottonwood trees, native grasses, and annual weeds.

Capability unit VIw-1, dryland; Overflow range site; Moderately Wet woodland site.

Anselmo series

Soils of the Anselmo series are moderately sandy and very friable. They developed from deep, wind-worked mixtures of sand and silt. They are in level, upland valleys, on gently sloping ridges, and on sloping to moderately steep hills.

The rather dark, sandy surface layer of the Anselmo soils is 10 to 20 inches thick. The upper part, where disturbed by cultivation and wind, is of very weak, coarse, blocky structure or is single grained. The lower part is fine sandy loam of weak, granular structure. Where the upper part of the surface layer has not been disturbed by wind, it is a darker fine sandy loam of granular structure. The surface layer is open and porous and is easily tilled. The brown, moderately sandy subsoil is medium blocky, or cloddy. The parent material varies from place to place; it is layered and ranges from sand to loam.

The Anselmo soils are darker and finer textured than the Valentine soils and are finer textured than the Dunday soils. They have a fine sandy loam subsoil of blocky structure that is not in the loose Valentine fine sands or the Dunday loamy fine sands. More sand is in their

subsoil than in that of the Keith, Ulysses, and Colby soils, which have a silt loam texture in that layer.

The Anselmo soils developed under a cover of short and mid grasses in which there are scatterings of western wheatgrass, little bluestem, side-oats grama, blue grama, switchgrass, prairie sandreed, and similar tall grasses.

Typical profile of an Anselmo soil in a cultivated field on a slope of about 1½ percent, 0.6 mile west and 100 feet south of NE. corner of SE¼ sec. 25, T. 4 N., R. 39 W.:

- A_p 0 to 8 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky (cloddy) structure that separates to single grains; loose when dry, very friable to loose when moist; abrupt, smooth boundary.
- A₁ 8 to 16 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, blocky structure breaking to weak, fine, granular structure; soft to slightly hard when dry, very friable when moist; clear, smooth boundary.
- B₂₁ 16 to 20 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, very friable when moist; clear, smooth boundary.
- B₂₂ 20 to 36 inches, dark brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, very friable when moist; clear, smooth boundary.
- B₂₃ 36 to 46 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, blocky structure; soft to slightly hard when dry, very friable when moist; clear, smooth boundary.
- C 46 to 54 inches, pale brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; massive; loose when dry, very friable to loose when moist; gradual, smooth boundary.
- C_{en1} 54 to 64 inches, very pale brown (10YR 7/3) loamy fine sand, pale brown (10YR 6/3) when moist; massive; soft when dry, very friable to loose when moist; calcareous, with disseminated lime; gradual, smooth boundary.
- C_{en2} 64 to 72 inches, very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) when moist; massive; soft to slightly hard when dry, friable when moist; calcareous, with disseminated lime.

The different layers range from loam to loamy sand and, in places, vary with depth, in the soil profile.

Lime is not everywhere present, but where it is, it is 1 to 6 feet or more below the surface.

Under cultivation, the Anselmo soils are best suited to corn, wheat, sorghum, rye, barley, vetch, and grass. Good yields can be expected when the soils have a good supply of moisture, when they are fertilized with nitrogen, phosphorus, and zinc, and when the surface layer is kept from blowing or washing. Soil temperatures increase rapidly early in spring and are rather high during summer. Under clean cultivation, the high temperature tends to increase the rate of decomposition, which, in turn, increases the hazards of soil blowing. The use of stubble and cover crops helps to control wind and water erosion and to maintain organic matter.

Anselmo fine sandy loam, 0 to 1 percent slopes (An).—This soil has a profile similar to the one described for the Anselmo series, except that the upper part of the surface layer is fine sandy loam instead of loamy fine sand. This upper part is darker in color and contains more organic matter, and its fine-textured materials have not been blown out by the wind. The soil is in smooth, level, up-

land valleys. Loamy, soft, weathered caliche occurs in some places at a depth of 4 feet or more. This soil is cultivated or in pasture.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Anselmo fine sandy loam, 1 to 3 percent slopes (AnA).—The profile of this soil is similar to the one described for the Anselmo series, but the upper part of the surface layer is fine sandy loam, is darker in color, contains more organic matter, is more stable, and contains more fine-textured materials, since these have not been blown out by the wind. This soil is like Anselmo fine sandy loam, 0 to 1 percent slopes, except that it is in parts of upland valleys that are very gently sloping instead of level. This soil is cultivated or in pasture.

Capability unit IIIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Anselmo fine sandy loam, 3 to 5 percent slopes (AnB).—The profile of this soil is similar to the one described for the series, but depth to the mixed sand and loam of the underlying parent materials is 18 to 40 inches instead of 20 to 52. This soil is on gently sloping, rounded ridges and is used mostly for pasture. Wind has not removed fine material and organic matter from the upper part of the surface layer. The rather dark fine sandy loam surface layer is about 14 inches thick. Lime, if present, occurs 1½ to 3½ feet from the surface.

Capability unit IIIe-3, dryland; IIIe-3, irrigated; Sandy range site; Sandy woodland site.

Anselmo fine sandy loam, 5 to 9 percent slopes (AnC).—The scattered areas of this soil are on slopes along the sides of creeks or are between the more nearly level uplands and the lowlands along the river. The soil has a rather dark, granular fine sandy loam surface layer, 10 to 14 inches thick. Its total thickness, depth to the mixed sandy and silty parent material, is 18 to 30 inches. Lime, if present, is 1 to 3 feet below the surface. Generally, this soil is in pasture.

Capability unit IVe-3, dryland; IVe-3, irrigated; Sandy range site; Sandy woodland site.

Anselmo fine sandy loam, 5 to 9 percent slopes, eroded (AnC2).—This soil is in positions similar to the un-eroded Anselmo fine sandy loam, 5 to 9 percent slopes. Because most of it is cultivated, it has been eroded. Wind has removed fine materials and organic matter from the upper few inches of the surface layer, and water has washed away part of this layer. In some places there are blown-out sandy spots, and in others, rills or ditches where water has run down slopes. The remaining surface layer is about 8 to 12 inches thick.

Capability unit IVe-3, dryland; IVe-3, irrigated; Sandy range site; Sandy woodland site.

Anselmo fine sandy loam, 9 to 30 percent slopes (AnD).—This soil is on moderately steep hills along the Republican River and its tributaries. The scattered areas occur between the very sandy Valentine soils and the silty Colby soils.

This is the most shallow Anselmo soil; it is only 16 to 24 inches deep to the parent material. The rather dark, granular, fine sandy loam surface layer is 8 to 14 inches thick. Lime, if present, is 1 to 2 feet below the surface.

Capability unit VIe-3, dryland; Sandy range site; Sandy woodland site.

Anselmo loamy fine sand, 0 to 3 percent slopes (AoAW).—The profile of this soil is like the profile described for the series. The soil is in upland valleys. It is slightly undulating or wavy, partly because soil material recently scoured from open places has been deposited around fences and vegetation. The upper part of the surface layer, 5 to 12 inches thick, has been winnowed, and much of the fine materials and organic matter has blown away. In places, part of the darker, granular fine sandy loam in the lower part of the surface layer has been mixed with the coarser surface soil during cultivation.

This soil includes small areas of Anselmo fine sandy loam, 0 to 1 percent slopes; of Anselmo fine sandy loam, 1 to 3 percent slopes; of Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes; and of Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes. Loamy, soft, weathered caliche is at a depth of 4 feet or more in some places. Most of this soil is cultivated.

Capability unit IIIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Anselmo loamy fine sand, 3 to 5 percent slopes (AoBW).—This soil is on gently sloping, rounded ridges. It differs from Anselmo fine sandy loam, 3 to 5 percent slopes, because, under cultivation, wind has removed fine materials and organic matter from the upper 4 to 8 inches of the surface layer. The entire surface layer is about 10 to 12 inches thick. Water has washed away some of the original surface layer and in places has exposed the fine sandy loam subsoil. There are some small, severely eroded spots where the parent material is exposed.

Small areas of Anselmo fine sandy loam, 3 to 5 percent slopes; Keith fine sandy loam, 3 to 5 percent slopes, eroded; and Valentine loamy fine sand are mapped with this soil.

Capability unit IIIe-3, dryland; IIIe-3, irrigated; Sandy range site; Sandy woodland site.

Banks series

In the Banks series are deep, nearly level to gently sloping, light-colored, very sandy soils on well-drained bottom lands along the Republican River.

The thin, sandy surface layer is 4 to 14 inches thick and of single grain or very weak, granular structure. It rests directly on the river sand. Lime is not always in the surface layer, but it is in the deeper, underlying material.

The Banks soils contain much more sand than the Havre soils. They are similar to the Valentine soils, but they contain lime and are on bottom lands. They resemble Sandy alluvial land, but have a darker surface layer, are on more uniform materials, and have a lower water table.

The native vegetation—sand grasses and sagebrush—is rather sparse. Prairie sandreed, little bluestem, sand bluestem, sand dropseed, and blue grama are some of the grasses.

Typical profile of a Banks soil in a pasture on a slope of about 2 percent, 0.15 mile north and 100 feet west of SE. corner of sec. 21, T. 1 N., R. 39 W.:

A₁₁ 0 to 2 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.

- A₁₂ 2 to 6 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) when moist; very weak, fine, granular structure; loose when dry, loose when moist; clear, smooth boundary.
- C₁ 6 to 24 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grain; loose when dry, loose when moist; abrupt, smooth boundary.
- C₂ 24 to 32 inches, grayish-brown (10YR 5/2) loamy very fine sand, dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, blocky (cloddy) structure; soft when dry, very friable when moist; calcareous, with spots of disseminated lime; abrupt, smooth boundary.
- A_{1b} 32 to 35 inches, gray (10YR 5/1) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, blocky (cloddy) structure; loose when dry, very friable when moist; abrupt, smooth boundary.
- C_{1b} 35 to 40 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) when moist; single grain; loose when dry, loose when moist; calcareous, with slight amounts of disseminated lime; gradual, smooth boundary.
- C_{2b} 40 to 50 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) when moist; single grain; loose when dry, loose when moist; calcareous, with abundant disseminated lime.

The surface soil ranges from loamy fine sand to fine sand. The underlying sandy river sediments are layered with loamy very fine sand to coarse sand. In some places medium-textured loamy material occurs deep in the underlying sediments.

Banks fine sand (Bb).—The profile of this soil is like that described for the Banks series. The soil occurs in nearly level places, but more of it is on long, narrow, gently sloping ridges that run parallel to the river. The water table is ordinarily at a depth below 6 feet. This soil is open, loose, and porous. It absorbs water very rapidly but is droughty, unstable, and low in fertility. Because it blows severely under cultivation, it is best suited to permanent grasses. Adapted grasses respond to good pasture management.

This soil is used mostly for pasture. The vegetation, though sparse, is well established in most places.

Capability unit VIe-5, dryland; Sands range site; Very Sandy woodland site.

Banks loamy fine sand (Bc).—The profile of this soil is similar to that described for the series, except that the surface layer is thicker and slightly finer textured. The surface layer, of weak, granular structure, ranges from 8 to 14 inches in thickness; it contains no lime in some places and abundant lime in others.

This soil is well suited to grasses but is poor to fair for crops. It is more stable than Banks fine sand, but extremely careful cultivation is necessary to keep it from blowing. Wheat, rye, barley, forage sorghum, and other close-growing stubble crops are best suited. Alfalfa is a suitable crop if there is plenty of moisture to a depth of 6 feet or more. This soil is responsive to fertilizer. It is used mostly for pasture, but a few areas are used for crops.

Capability unit IVE-5, dryland; IVE-5, irrigated; Sandy range site; Sandy woodland site.

Bayard series

In this series are moderately sandy, nearly level to very gently sloping soils that are developing in deep recent deposits near the base of upland slopes or in higher places in stream and river valleys that have been built

up by wind and water. They contain much lime in most places.

The rather light colored to moderately dark fine sandy loam surface layer is 6 to 14 inches thick and is very easily tilled. On wind-eroded areas the surface layer is 6 to 10 inches of loamy fine sand or fine sand. The underlying material is light-colored, limy, assorted sand and silt that have been moved down from higher slopes by wind and water.

The Bayard soils differ from the Bridgeport soils in being sandy instead of silty.

The native vegetation is short and mid grasses, with scatterings of western wheatgrass, side-oats grama, little bluestem, blue grama, switchgrass, prairie sandreed, and other tall grasses.

Typical profile of a Bayard soil in a cultivated, eroded field with an undulating slope of about 2 percent, 0.24 mile west and 250 feet north of SE. corner of sec. 16, T. 1 N., R. 37 W.:

- A_{pt} 0 to 6 inches, light brownish-gray or grayish-brown (10YR 5.5/2) loamy fine sand or fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose when dry, loose when moist; calcareous, with slight amounts of disseminated lime; abrupt, smooth boundary.
- A_{p2} 6 to 9 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 3.5/2) when moist; single grain; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; gradual smooth boundary.
- A₁ 9 to 17 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure separating to weak, fine, granular or crumb structure; soft when dry, very friable when moist; clear smooth boundary.
- AC 17 to 30 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; gradual, smooth boundary.
- C₁ 30 to 48 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; gradual, smooth boundary.
- C₂ 48 to 60 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; abrupt, smooth boundary.
- A_{1b} 60 to 70 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; massive; soft to slightly hard when dry, very friable when moist; calcareous, with abundant disseminated lime.

The surface layer is rather light in some places and rather dark in others. Color depends mostly on the source material, the amount of wind erosion, and the length of time the soil has been in place and accumulating organic matter.

Under cultivation, the Bayard soils are best suited to wheat, rye, barley, and grass. Good yields of wheat, rye, and barley can be expected when the soils contain sufficient moisture, and when the stubble is returned to the surface layer to maintain organic matter and keep the soils from blowing. Sorghum is somewhat affected by yellowing because of the deficiency of iron, and corn is somewhat affected by the inadequate supply of zinc and phosphorus. Good yields of sorghum and corn can be obtained if they are rotated with close-growing crops or if sufficient stubble is added and the soils are fertilized

with nitrogen, phosphorus, zinc, and iron. Alfalfa and sugar beets are suitable crops, but they need plenty of moisture and phosphorus.

Bayard fine sandy loam, 0 to 1 percent slopes (Bf).—The profile of this soil is similar to that described for the series, but the upper part of the surface layer is not loamy fine sand; it is slightly darker and contains more organic matter. The fine materials have not been blown out by the wind. Most of this soil is cultivated.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Bayard fine sandy loam, 1 to 3 percent slopes (BfA).—The profile of this soil is similar to the one described for the series, but the upper part of the surface layer is not a loamy fine sand and is darker and contains more organic matter. The fine materials have not been blown out by the wind. This soil is like Bayard fine sandy loam, 0 to 1 percent slopes, but is smooth and very gently sloping instead of nearly level. Most of this soil is cultivated.

Capability unit IIIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Bayard loamy fine sand, wind-hummocky (BfA2).—This soil has a profile like the one described for the series. It is very gently sloping. The slopes are slightly undulating or wavy because the wind has scoured soil material from open places and deposited it in others. The surface layer has been winnowed, and much of the fine material and organic matter has blown away. Small areas of Bayard fine sandy loam, 0 to 1 percent slopes, and 1 to 3 percent slopes, are mapped with this soil. This soil is cultivated.

Capability unit IIIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Blown-out land

Blown-out land occurs where soil material has been removed by wind. It is barren or nearly so.

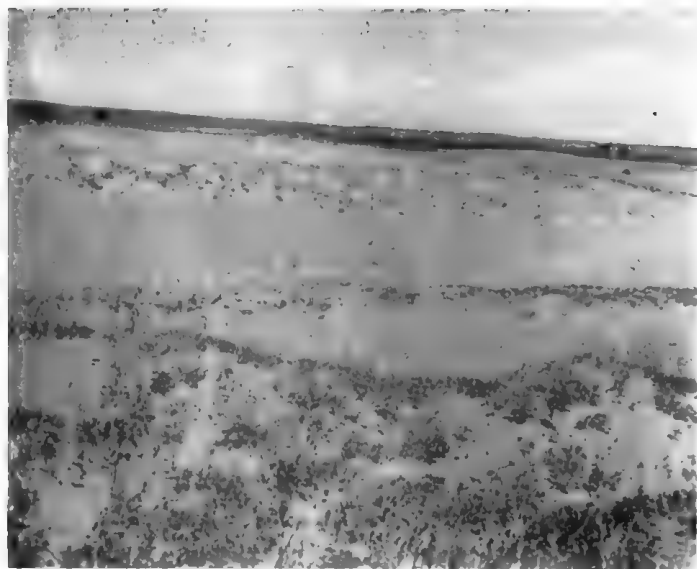


Figure 29.—Blown-out land.



Figure 30.—Bridgeport soil in the foreground and Colby soil in the background.

Blown-out land (B).—This land type (fig. 29) is in patches 5 to 60 acres in size. It is on hummocky slopes within areas of the Valentine soils. An area mapped as Blown-out land may be one large blowout or a series of small ones, and the soil on its outer edges has been covered with drifted sand. A few areas in the hills on the south side of the Republican River consist of limy, loamy fine sand or coarse sand of the Ogallala formation.

There is sufficient vegetation in and around most of the areas to keep the sand from drifting any great distance. But the kind and amount of vegetation vary from year to year and from place to place, because the land is used and managed differently, and because there is a difference in the amount of rain and wind. The pitted part of a blowout is nearly always bare of vegetation.

Under good management and with favorable moisture, smooth areas stabilize in a few years. Steep areas require earth moving and filling and several years of seeding before they are stabilized. Most of this land is in pastures or abandoned fields.

Capability unit VIe-5, dryland; Sands range site; Very Sandy woodland site.

Bridgeport series

These are level to sloping, silty soils that are developing from recent, deep, loamy deposits near the base of upland slopes (fig. 30) or in high places on the river lowlands. They contain little organic matter, are rather light colored, and contain excess lime.

The rather light colored loam surface layer is 6 to 14 inches thick and of weak, granular or of weak, medium, blocky structure. It is easily tilled. The light-colored material directly beneath the surface layer consists of limy assorted material that worked and washed down from raw breaks and gullies, as well as some darker material washed from the surface layer of soils on slopes above.

The native vegetation is western wheatgrass, side-oats grama, little bluestem, blue grama, and other short and mid grasses.

Typical profile of a Bridgeport soil in a field on a slope of between 1 and 2 percent, 0.25 mile north and

0.1 mile east of SW. corner of sec. 36, T. 2 N., R. 37 W., about 120 feet north of U.S. Highway 34 and 540 feet east of culvert:

- A_{1p} 0 to 5 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, medium and coarse, blocky (cloddy) structure; soft when dry, very friable when moist; calcareous, with disseminated lime; gradual, smooth boundary.
- AC 5 to 11 inches, light brownish-gray (10YR 6.5/2) loam, grayish brown (10YR 5/2) when moist; weak, coarse, blocky structure; soft when dry, very friable when moist; calcareous, with disseminated lime, and a few spots and threads of lime; gradual, smooth boundary.
- C₁ 11 to 23 inches, very pale brown (10YR 6.5/3) loam, brown (10YR 5/3) when moist; weak, coarse, blocky structure; soft when dry, very friable when moist; calcareous, with disseminated lime, as well as pores, cracks, and cavities filled with spots and threads of white lime; abrupt, smooth boundary.
- C₂ 23 to 35 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5.5/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, friable when moist; calcareous, with disseminated lime, and a few threads of white lime; abrupt, smooth boundary.
- A_{11b} 35 to 47 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3.5/2) when moist; weak, fine and very fine, granular structure; soft when dry, very friable when moist; gradual, smooth boundary.
- A_{12b} 47 to 56 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky structure separating into weak, very fine granules; soft when dry, very friable when moist; calcareous, with disseminated lime; gradual, smooth boundary.
- A_{13b} 56 to 66 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, coarse, blocky structure separating into weak, very fine granules; soft when dry, very friable when moist; calcareous, with disseminated lime.

The surface layer is light and dark, depending mostly upon the source of the soil material and the length of time it has been in place and accumulating organic matter. In a few places the parent material contains scattered pebbles, sand or gravel, or clayey material derived from outcrops of rock, sand, gravel, and shale on the higher upland slopes.

Under cultivation, the Bridgeport soils are best suited to wheat, rye, barley, and grass. Sorghum is somewhat affected by yellowing because there is not an adequate supply of iron. Corn is also somewhat affected by the deficiency of zinc. Alfalfa is a suitable crop, but it needs much moisture and phosphorus. Sugar beets are suited, but they require much water. Good yields of wheat, rye, and barley can be expected when the soils have a good supply of moisture and when the stubble is returned to the soils to supply organic matter. Good yields of sorghum and corn can be obtained if there is good moisture and if the right amounts of nitrogen, phosphorus, zinc, and iron are added.

Bridgeport loam, 0 to 1 percent slopes (Bh).—The profile of this soil is similar to the profile described for the series. Moisture is the first limitation, and fertility is second. Yields improve if fertilizer is applied, moisture is conserved, and other management is good. Most of this soil is cultivated.

Capability unit IIe-1, dryland; I-1, irrigated; Silty range site; Silty to Clayey woodland site.

Bridgeport loam, 1 to 3 percent slopes (BhA).—The profile of this soil is like that described for the series.

The soil is on foot slopes. Since it is slightly sloping, this soil requires a little protection from water and wind. It is used mostly for cultivated crops. Crops respond to fertilizer and practices that conserve moisture.

Capability unit IIe-1, dryland; IIe-1, irrigated; Silty range site; Silty to Clayey woodland site.

Bridgeport loam, 3 to 5 percent slopes (BhB).—This soil is similar to the one described for the series. The soil, however, is on the lower part of steep upland hills. The main hazard is water from adjacent hills, which adds to normal rill erosion. The soil responds well to good management, including fertilizing, conserving water, and controlling erosion. Areas of Bridgeport soil with stronger slopes and small areas of Ulysses silt loam, 5 to 9 percent slopes, are mapped with this soil. This soil is cultivated or in pasture.

Capability unit IIIe-1, dryland; IIIe-1, irrigated; Silty range site; Silty to Clayey woodland site.

Canyon series

In this series are nearly level to steep, shallow soils that rest on limestone and sandstone bedrock. They commonly occur in patches or narrow strips within areas of other soils of the uplands, on breaks along streams, or on slopes toward valleys.

The surface layer is 4 to 12 inches thick. It is limy and contains scattered gravel and small rock fragments. The limy bedrock is directly below the surface layer.

Canyon soils are similar to the Vebar soils, but the bedrock is closer to the surface. The native vegetation consists mainly of short grasses, and blue grama is dominant.

Typical profile of a Canyon soil in a pasture on a slope of about 3 percent, 0.25 mile south, 0.3 mile east, and 100 feet north of NW. corner of sec. 27, T. 2 N., R. 41 W.:

- A₁ 0 to 8 inches, dark grayish-brown (10YR 4.5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; contains some gravel and rock fragments; weak, coarse and medium, prismatic structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; clear, wavy boundary.
- AC 8 to 12 inches, grayish-brown (10YR 5/2) sandy loam, dark grayish brown (10YR 3.5/2) when moist; abundant gravel and small rock fragments; massive; loose when dry, very friable when moist; calcareous, with abundant disseminated and segregated lime; abrupt, wavy boundary.
- D 12 to 16 inches +, pinkish-white (7.5YR 8/2), slightly weathered Ogallala limestone and sandstone of Tertiary age; pinkish gray (7.5YR 7/2) when moist.

The Canyon soils are too shallow for cultivated crops. They are best suited to short and mid grasses, and they respond to good pasture management.

Canyon fine sandy loam, 3 to 5 percent slopes (CgB).—This is the only Canyon soil in the county. Its profile is like the profile described for the series. The soil is on uplands where the bedrock has not been deeply covered by sand.

This soil is cultivated or in pasture. Much of the acreage farmed occurs as small patches within other soil areas. The cultivated soil has a thin, wind-whipped, loamy fine sand surface layer on which rock fragments are scattered. A small acreage of Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes, is included with this soil.

Capability unit VI_s-4, dryland; Shallow range site; Shallow woodland site.

Colby series

These are light-colored, smooth, gently sloping to steep soils on uplands where runoff is somewhat excessive. They are developing from deep deposits of silty loess or loesslike material. Their surface layer is thin and almost everywhere contains much lime. These soils are mainly in the eastern and southern parts of the county, on slopes toward the Republican River. They are associated with Rough broken land, loess.

The surface layer, slightly darkened by humus, is 3 to 10 inches thick and is of weak, fine, crumb or granular structure. The parent material is light-colored, flourlike silt that contains much finely divided lime.

Colby soils are lighter colored than the Ulysses and Keith and do not have the blocky subsoil of those soils.

The Colby soils developed under a cover of western wheatgrass, little bluestem, side-oats grama, blue grama, and other mid and short grasses.

Typical profile of a Colby soil in a pasture on a slope of about 12 percent, 0.75 mile west and 0.3 mile south of NE. corner of sec. 4, T. 2 N., R. 36 W.:

- A_{1p} 0 to 6 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 3.5/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; clear, smooth boundary.
- AC 6 to 11 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime, as well as cracks, cavities, and pore spaces filled with white lime; gradual, smooth boundary.
- C 11 to 20 inches +, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; massive; soft when dry, very friable when moist; calcareous, with abundant disseminated lime and a few threads of white lime.

The Colby soils erode seriously when farmed. They contain little organic matter and are low in fertility. Costs of farming and fertilizing, in relation to returns, prohibit using these soils for crops. They are well suited to western wheatgrass, side-oats grama, little bluestem, blue grama, and other native mid and short grasses. In most places these soils can be cultivated enough to prepare them for planting trees, seeding permanent grasses, or interseeding grasses. Some areas, however, are too steep for farming equipment. These soils respond to pasture management that will save moisture, control erosion, and maintain high production of forage.

Colby loam, 3 to 9 percent slopes (CdCW).—This soil has a profile similar to the profile described for the series. The soil is on smooth knolls or side slopes. In some places it occurs as small, light-colored patches within other soil areas, especially of Keith silt loam, 3 to 5 percent slopes, eroded, and of Ulysses silt loam, 5 to 9 percent slopes, eroded.

This soil is light colored and has much finely divided lime. It was once like the Ulysses soils, but severe water erosion has removed much of the surface layer. Part of the light, silty, underlying parent material is mixed in with the present surface layer.

Most of this soil is cultivated, but cultivation is not desirable. It would be better to use it for trees or permanent grasses.

Capability unit IV_e-1, dryland; Silty range site; Silty to Clayey woodland site.

Colby loam, 9 to 30 percent slopes (CdDW).—The profile of this soil is like the profile described for the series. The soil is on valley slopes along tributaries of the Republican River. The slopes, overall, are smooth, but they vary abruptly within short distances, which makes it impossible to map separately the small areas of other kinds of soils. Consequently, this soil includes small acreages of Rough broken land, loess, on steep, abrupt slopes; of Ulysses silt loam, 5 to 9 percent slopes, on isolated, smooth slopes; of Bridgeport loam, 1 to 3 percent slopes; of Bridgeport loam, 3 to 5 percent slopes, on filled in places around drainageways; and of Broken alluvial land, on narrow and flat canyon bottoms.

A few, small, cultivated areas have been severely damaged by sheet and rill erosion. The rest of this soil is in pasture. Accelerated erosion takes place in overgrazed pastures and around farmyards, corrals, wells, or cattle paths. Only the smoother parts of this soil can be cultivated enough to plant trees and to seed or interseed permanent grasses.

Capability unit VI_e-1, dryland; Silty range site; Silty to Clayey woodland site.

Dunday series

The Dunday soils are nearly level to very gently sloping, moderately dark, and sandy. They developed from deep eolian sand. They are in sandhill valleys and are near the sandy, hummocky Valentine soils and the subirrigated Elsmere soils.

The moderately dark loamy fine sand surface layer is 10 to 18 inches thick and of weak, granular structure. The underlying materials are layers of light- and dark-colored loamy fine sand. In many places rather dark loamy fine sand, an old surface soil, lies 1 to 3 feet below the present surface. There is no free lime.

The Dunday soils are thicker, darker, and finer textured than the Valentine soils and have more body and are more coherent. They contain coarser materials, have less body, and are less coherent than the Anselmo soils. The loamy fine sand material underlying Dunday soils has only little structure, compared to the loose fine sand of the Valentine soils and the natural blocky fine sandy loam in the subsoil of Anselmo soils.

The native vegetation is mid grasses, scatterings of tall grasses, and small to only moderate amounts of sand sagebrush. The main grasses are little bluestem, sand bluestem, switchgrass, and prairie sandreed, with scatterings of western wheatgrass.

Typical profile of a Dunday soil in a pasture on a slope of about 1½ percent, center of NW¼ of sec. 29, T. 3 N., R. 37 W.:

- A₁₁ 0 to 2 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, very fine, granular structure; soft when dry, very friable when moist; clear, smooth boundary.
- A₁₂ 2 to 7 inches, dark grayish-brown (10YR 4.5/2) loamy fine sand, very dark grayish brown (10YR 3.5/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; clear, wavy boundary.

- A₃ 7 to 14 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky structure separating to weak, fine, granular structure; tends to separate to single grains; soft to loose when dry, very friable to loose when moist; abrupt, wavy boundary.
- A_{1b} 14 to 26 inches, dark grayish-brown (10YR 4.5/2) loamy fine sand, very dark grayish brown (10YR 3.5/2) when moist; weak, coarse, blocky structure separating to weak, medium and fine, blocky structure; soft when dry, very friable when moist; gradual, wavy boundary.
- C₁ 26 to 36 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; weak, medium, blocky structure separating to single grains; soft to loose when dry, loose when moist; gradual, wavy boundary.
- C₂ 36 to 60 inches, light brownish-gray (10YR 6/2) loamy sand, grayish brown (10YR 5/2) when moist; single grain; loose when dry, loose when moist.

The Dunday soils are well suited to grasses but are poor to fair for crops. They contain moderate amounts of organic matter, are porous and absorb water readily, and have a moderately high water-holding capacity. They are fairly loose, however, and are easily eroded by wind. When they are first plowed, the grass roots and organic matter in them act as binders of the soil particles and help keep the water-holding capacity fairly high. After a few years of clean cultivation, however, the grass roots disappear, the organic matter is burned up, and the soils become unstable and unable to resist wind action. Under cultivation, they need care that keeps the organic matter high. This is done by tilling infrequently; growing rye, alfalfa with grass, wheat, closely planted sorghum and vetch, and other close-growing crops; and keeping residue on or near the surface. These soils also respond to fertilizer.

Dunday loamy fine sand (Du).—The profile of this soil is like the profile described for the Dunday series. The soil is in upland valleys in the sandhills and is well drained and nearly level to very gently sloping. In native pasture, it supports a thicker stand of tall grasses and less sand sagebrush than the pastures on the hummocky Valentine soils. In disturbed or cultivated areas, the wind has blown out the fine materials and organic matter. The upper part of the surface layer in these wind-eroded places is fine sand or sand. Small areas of Dunday loamy fine sand, loam substratum, are mapped with this soil. This soil is in pasture or is cultivated.

Capability unit IVE-5, dryland; IVE-5, irrigated; Sandy range site; Sandy woodland site.

Dunday loamy fine sand, loam substratum (2Du).—This soil occurs mainly in the northwestern part of the county, in upland valleys in the sandhills. It is deep and has a profile similar to the one described for the series. The surface layer, however, is a rather thick accumulation of loamy fine sand, which overlies finer textured loamy materials.

The loamy material, 1½ to 4 feet below the surface, consists of mixed sand and silt from soft, weathered caliche that is of fine sandy loam to clay loam texture. In many places an old soil is on the loamy caliche material, and this soil is cemented and hard when dry. It has the characteristics of a former alkali or water-table soil.

Dunday loamy fine sand, loam substratum, is better drained than Elsmere fine sandy loam, 0 to 1 percent

slopes. The water table is 8 to 15 feet below the surface.

Most of this soil is in pasture. The native grasses are thicker, and there is less sand sagebrush than on the Valentine fine sand, rolling. The grasses, however, are not so thick or so tall as on Elsmere fine sandy loam, 0 to 1 percent slopes. In disturbed or cultivated areas, the wind has blown out the fine materials and organic matter, and the upper surface layer is fine sand or sand.

Small areas of Dunday loamy fine sand; Elsmere fine sandy loam, 0 to 1 percent slopes; and Ovina fine sandy loam, 0 to 1 percent slopes, were included with this soil in mapping.

Capability unit IVE-5, dryland; IVE-5, irrigated; Sandy range site; Sandy woodland site.

Elsmere series

The Elsmere soils are medium to dark in color. They have a sandy surface layer and are underlain by sand. They are in level places in upland valleys or on the lower slopes along the sides of spring-fed creeks. These soils are in the northwestern part of the county, where they are associated with the Valentine, Dunday, Ovina, and Gannett soils.

The dark surface layer is fine sandy loam, 10 inches thick on the average, but ranging from 6 to 16 inches. It is high in lime. The underlying material is rather light-colored sand or loamy sand. The water table is 2 to 6 feet below the surface.

The Elsmere soils are darker than the Valentine or Dunday soils, and the water table is much higher than in the Valentine or Dunday soils. They are not so dark or so wet, however, as the Gannett soils. They resemble the Ovina soils, except for their sandy underlying materials. The Ovina soils, in contrast, have silty underlying materials.

The native vegetation is a thick stand of tall prairie grasses, including Indiangrass, switchgrass, and big bluestem. In places there is an understory of saltgrass and small sedges.

Typical profile of an Elsmere soil in a pasture on a slope of less than 1 percent, 0.15 mile south and 400 feet west of northeastern corner of NW¼ of sec. 8, T. 2 N., R. 41 W.:

- A_p 0 to 4 inches, gray (10YR 5/1) loamy fine sand, very dark gray or very dark grayish brown (10YR 3/1.5) when moist; weak, fine, granular structure; loose when dry, very friable when moist; calcareous, with abundant disseminated lime; pH at 1:2 suspension, 7.9; soluble salt, 0.06 percent; abrupt, smooth boundary.
- A₁ 4 to 12 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, coarse and medium, blocky structure separating to weak, fine, granular structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; pH at 1:2 suspension, 8.6; soluble salt, 0.06 percent; clear, wavy boundary.
- A_{1b} 12 to 18 inches, gray (10YR 5/1) loamy fine sand, very dark gray (10YR 3/1) when moist; weak, coarse and medium, blocky structure separating to weak, fine, granular structure; loose when dry, very friable when moist; calcareous, with abundant disseminated lime; pH at 1:2 suspension, 8.6; soluble salt, 0.06 percent; clear, smooth boundary.
- C_{1b} 18 to 25 inches, gray or grayish-brown (2.5Y 5/1.5) fine sandy loam, very dark grayish brown or dark grayish brown (2.5Y 3.5/2) when moist; weak, coarse and medium, blocky structure; soft when dry, very friable when moist; some small, brown mottles and

a few soft, white concretions; calcareous, with abundant disseminated lime; pH at 1:2 suspension, 8.1; soluble salt, 0.10 percent; clear, smooth boundary.

- C_{2b} 25 to 45 inches, light brownish-gray (2.5Y 6/2) loamy fine sand, grayish brown (2.5Y 5/2) when moist; weak, medium, blocky structure; loose when dry, loose when moist; some small, brown mottles and a few soft, white concretions; calcareous, with moderate amounts of lime; clear, smooth boundary.
- C_{3b} 45 to 50 inches, light brownish-gray (10YR 6/1.5) sand, grayish brown (10YR 5/1.5) when moist; single grain; loose when dry, loose when moist; noncalcareous.

The Elsmere soils are excellent for grass and produce good hay crops in most years. They are poor to fair for other crops because in wet years the crops drown out, and in dry years the organic matter burns up and the soils blow badly. Crops require phosphorus and may respond to other fertilizer. Alfalfa is the best suited crop. The amount and quality of wild hay produced in native meadows depend upon management.

Elsmere fine sandy loam, 0 to 1 percent slopes (Es).—The profile of this soil is like the profile described for the series. This soil is in level, subirrigated valleys within the sandhills. It includes small areas of Dunday loamy fine sand, loam substratum, and of Ovina fine sandy loam, 0 to 1 percent slopes. Almost all of this soil is used for native meadow or pasture (fig. 31).

Capability unit IVw-5, dryland; IVw-5, irrigated; Subirrigated range site; Moderately Wet woodland site.

Elsmere fine sandy loam, 1 to 5 percent slopes (EsC).—The profile of this soil is similar to the profile described for the series, but the soil is more sloping and is along spring-fed creeks. It is used for hay or pasture.

Capability unit VIw-5, dryland; Subirrigated range site; Moderately Wet woodland site.

Gannett series

The Gannett soils are very dark, wet, and moderately sandy. They are in level pockets, upland valleys, or swales within areas of the sandhills.

The black surface layer is 12 to 30 inches of fine sandy loam that has much organic matter in the top few inches. This layer also contains lime. The underlying material is mixed sand and silt; it is lighter colored than the surface layer and does not contain lime.



Figure 31.—Good-quality hay on Elsmere fine sandy loam, 0 to 1 percent slopes; Valentine fine sand, rolling, in the background.

The Gannett soils are darker and wetter than the Elsmere soils. They occur in positions similar to those occupied by Scott soils, but the Scott soils are developing in fine-textured materials and do not have a high water table.

The native vegetation on Gannett soils is a rank growth of prairie cordgrass and sedges.

Typical profile of a Gannett soil in a hay meadow with a slope of less than 1 percent, NW. corner of SW $\frac{1}{4}$ of sec. 16, T. 2 N., R. 41 W.:

- A₀ 0 to 3 inches, dark grayish-brown (10YR 4/2, moist), matted, organic loam; nonsticky when wet; calcareous, with abundant soluble lime; abrupt, smooth boundary.
- A₁ 3 to 9 inches, black (10YR 2/1, moist) fine sandy loam; weak, coarse, blocky structure; nonsticky when wet; calcareous, with abundant soluble lime grading to only a small amount; clear, smooth boundary.
- A₁₂ 9 to 22 inches, black (2.5Y 2/0, moist) very fine sandy loam; weak, coarse, blocky structure; sticky when wet; clear, smooth boundary.
- A₁₃ 22 to 31 inches, black (2.5Y 2/0, moist) loam; weak, coarse, blocky structure; sticky when wet; abrupt, smooth boundary.
- AC_x 31 to 48 inches, dark-gray (2.5Y 4/0, moist) fine sandy loam; massive; slightly sticky when wet; gradual, smooth boundary.
- C_x 48 to 60 inches, gray (2.5Y 5/0, moist) loamy very fine sand; massive; sticky when wet.

Gannett soils are not suitable for cultivation because they are too wet, but they are among the best soils for hay.

Gannett fine sandy loam (Gc).—This is the only Gannett soil mapped in the county. Its profile is like the profile described for the series. The soil is used entirely for hay or pasture, for which it is best suited.

Capability unit Vw-1, dryland; Wet Land range site; Wet woodland site.

Glendive series

The Glendive soils are nearly level, well-drained, very friable soils of the bottom lands. They are developing in deep, moderately sandy, river or stream materials.

The rather dark surface layer is about 12 inches of fine sandy loam that is granular in structure and contains much lime. The underlying material is also fine sandy loam that contains much lime.

The Glendive soils do not have the loam or silt loam underlying material of the Havre soils, nor the sand of the Banks soils. They are similar to the Bayard soils, but they are not on upland slopes or higher places.

The native vegetation is mixed grasses, mainly western wheatgrass, little bluestem, side-oats grama and other mid grasses.

Typical profile of a Glendive soil in a cultivated field with a slope of less than 1 percent, 0.2 mile north and 50 feet east of SW. corner of sec. 16, T. 1 N., R. 37 W.:

- A_p 0 to 6 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; calcareous, with slight amount of disseminated lime; abrupt, smooth boundary.
- A₁ 6 to 12 inches, grayish-brown (10YR 3/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic separating to weak, fine, granular structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; gradual, smooth boundary.

- C₁ 12 to 30 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3.5/3) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; gradual, smooth boundary.
- C₂ 30 to 48 inches, grayish-brown (10YR 5/2) loamy very fine sand, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; calcareous, with slight to moderate amount of disseminated lime.

- B₃ 32 to 42 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic separating to weak, medium and fine, subangular blocky structure; hard when dry, friable when moist; calcareous, with moderate amount of disseminated lime; clear, smooth boundary.
- C 42 to 60 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; calcareous, with moderate to abundant disseminated lime and a few threads of white lime.

The underlying material is layered and varies in color. The texture ranges from loamy fine sand to very fine sandy loam. In some places layers of sand or loam are 2 to 6 feet below the surface.

Blowing is a problem on the sandier soils of this series. Use of stubble crops, stubble-mulch farming, or strip-cropping helps to hold the soils in place, to add organic matter to the surface layer, and to conserve moisture. Under cultivation the Glendive soils are best suited to wheat, corn, barley, rye, sorghum, and grass. Crops respond to nitrogen, phosphorus, and zinc. Corn apparently needs zinc more than other crops commonly grown.

Glendive fine sandy loam (Gcl).—This soil has a profile like the one described for the series. It is associated with Havre soils, and most of it is used for crops.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Goshen series

The Goshen soils are dark and nearly level. They are in swales on the uplands or on slopes along small upland drainageways. They developed from deep, dark materials that washed in or worked down from surrounding soils.

The dark surface layer is about 20 inches thick, is of granular structure, and is easily tilled. The dark subsoil generally is blocky, or cloddy. The parent material ranges from dark to light colored and, in most places, consists partly of silty loess that contains lime.

The Goshen soils differ from the Bridgeport soils in position, as they do not occur on upland slopes or higher places. They are also thicker and darker than Bridgeport soils, and they do not have lime in the plow layer. They are darker and thicker than the associated Keith and Ulysses soils. They are better drained than the Scott soils and have less clay in their subsoil.

The Goshen soils developed under a cover of blue grama, western wheatgrass, and other short and mid grasses.

Typical profile of a Goshen soil in a cultivated field on a slope of less than 1 percent, 0.1 mile north and 375 feet west of SE. corner of sec. 12, T. 4 N., R. 37 W.:

- A_p 0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, very fine, crumb or granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.
- A₁ 6 to 24 inches, very dark gray (10YR 3/1) silt loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic separating to weak, fine, granular structure; slightly hard when dry, very friable when moist; clear, smooth boundary.
- B₂ 24 to 32 inches, dark grayish-brown (10YR 3.5/2) silt loam, very dark grayish brown (10YR 2.5/2) when moist; weak, coarse, prismatic separating to moderate, medium and fine, subangular blocky structure; hard when dry, friable when moist; clear, smooth boundary.

The subsoil varies between very fine sandy loam and silty clay loam, and the structure is not always blocky, or cloddy.

The Goshen soils are naturally highly productive. They are fertile and contain much organic matter. They absorb water readily and store it well. Although they receive some runoff in addition to direct rainfall, moisture is the principal factor limiting their use. The main problems are maintaining a balance between moisture and fertility and, on the sandier soils, checking soil blowing.

These soils are best suited to corn, sorghum, wheat, and other small grains. During wet years, small grains grow rank and tend to lodge badly. During dry years, corn and other row crops may burn.

Goshen fine sandy loam, 0 to 1 percent slopes (Gf).—This soil is in upland swales or along upland drainageways within areas of the more sandy Anselmo and Keith soils. Its profile is similar to the one described for the Goshen series, but the subsoil is a loam that contains a little more fine sand and is not so blocky. Most of the soil is cultivated.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Goshen silt loam, 0 to 1 percent slopes (Gh).—The soil is in swales on nearly level uplands in the eastern part of the county. It has a profile like the one described for the series. The soil occurs with the silty Keith and Ulysses soils and with the poorly drained, clayey Scott soils. It includes small areas of Keith silt loam, thick, 0 to 1 percent slopes, and of Scott silt loam. Most of this Goshen soil is used for crops.

Capability unit IIc-1, dryland; I-1, irrigated; Silty range site; Silty to Clayey woodland site.

Havre series

The Havre soils formed on well-drained bottom lands along the Republican River, in deep to moderately deep, loamy sediments that overlie coarser sand and gravel.

The rather light to moderately dark surface layer is limy and 6 to 12 inches thick. It is granular and easily tilled, and it rests directly on dark- and light-colored, loamy sediments that also contain much lime. In some places there is a dark, buried surface layer below the present surface layer. This dark layer occurs where receding high floodwaters have deposited silty materials over a layer that had accumulated organic matter.

The Havre soils contain much less sand than the Banks soils and differ from the Bridgeport soils in forming in layered river sediments at lower elevations. They differ from Glendive soils in having a loam texture, rather than fine sandy loam. They are better drained than the Las soils.

The native vegetation is western wheatgrass, side-oats grama, blue grama, and other short and mid grasses.

Typical profile of a Havre soil in a cultivated field on a slope of less than 1 percent, 250 feet north and 790 feet west of SE. corner of sec. 23, T. 1 N., R. 39 W.:

- A_p 0 to 4 inches, grayish-brown (10YR 5/2) coarse loam, dark grayish brown (10YR 4/2) when moist; weak, medium, blocky structure separating to weak, medium and fine, granular structure; soft when dry, very friable when moist; calcareous, with slight amount of disseminated lime; abrupt, smooth boundary.
- A₁ 4 to 12 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky structure separating to weak, medium and fine, granular structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; abrupt, smooth boundary.
- C₁ 12 to 24 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, blocky structure separating to moderate, medium, granular structure; hard when dry, friable when moist; calcareous, with abundant disseminated lime; abrupt, smooth boundary.
- C₂ 24 to 28 inches, very pale brown (10YR 7/3) very fine sandy loam, brown (10YR 5/3) when moist; weak, coarse and medium, blocky structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; abrupt, smooth boundary.
- C₃ 28 to 40 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, blocky structure separating to moderate, medium and fine, granular structure; hard when dry, friable when moist; calcareous, with abundant disseminated lime; clear, smooth boundary.
- C₄ 40 to 50 inches, very pale brown (10YR 7/3) very fine sandy loam, brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; gradual, smooth boundary.
- C₅ 50 to 64 inches, light brownish-gray (10YR 6/2), thin lenses of sand and silt, grayish brown (10YR 5/2) when moist; massive; soft when dry, very friable when moist; calcareous, with moderate amount of disseminated lime; abrupt, wavy boundary.
- D 64 to 70 inches, light-gray (10YR 7/2) river sand.

The texture of the C horizons ranges from fine sandy loam to silty clay loam. Depth to the coarser textured river sand ranges from 30 inches to 6 feet from the surface. In a few places alkali or soluble salts occur 2 feet or less from the surface.

Havre fine sandy loam (Hf).—The profile of this soil is similar to the one described for the Havre series, but the surface layer is fine sandy loam, instead of loam, and is more apt to blow. Included with this soil are small areas of Glendive fine sandy loam.

This soil is cultivated or in pasture. Crops that provide stubble are needed to increase organic matter, and if the stubble is kept on the surface, it helps to control blowing. This soil is suitable for the same crops as Havre loam.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Havre loam (Hh).—The profile of this soil is like the one described for the series. The soil is level, absorbs water readily, and stores moisture well, but yields of crops are somewhat uncertain because of the limited rainfall. Soil fertility is a problem. Lime ties up the iron in the soil; sorghum, therefore, is somewhat affected by yellowing. Shortage of zinc and phosphorus somewhat affects growth of corn.

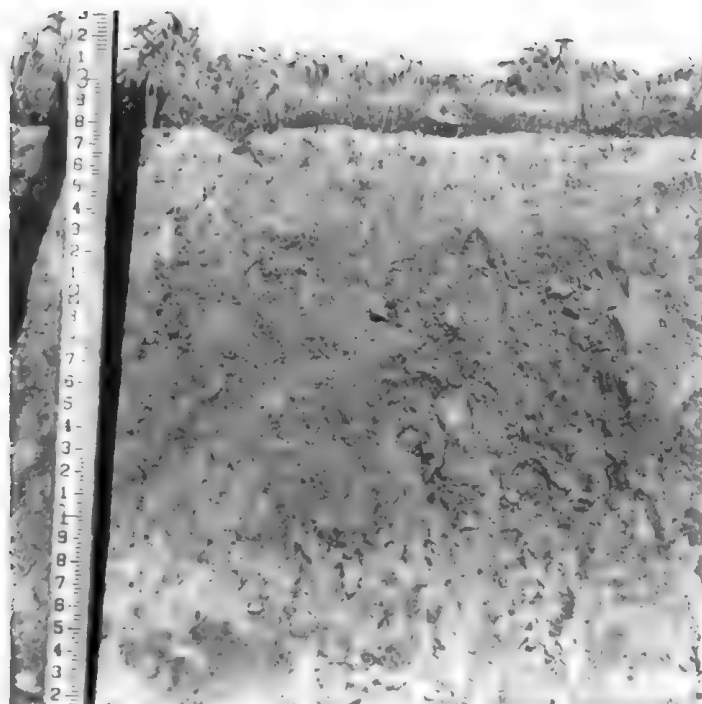


Figure 32.—Profile of Keith silt loam showing surface layer about 8 inches thick, subsoil about 16 inches thick, and light-colored, limy parent material about 2 feet below the surface. Because some organic matter has been lost during cultivation, the remaining part of the original surface layer is of lighter color than the subsoil.

This soil is best suited to wheat, rye, barley, and other small grains, and good yields can be expected when there is much moisture. Good yields of sorghum and corn can be expected if the soil is fertilized with nitrogen, phosphorus, zinc, or iron, and if small grains are included in the rotation. Alfalfa is well suited but needs much moisture and phosphorus.

Small areas of Glendive fine sandy loam are included with this soil in mapping.

Capability unit IIc-1, dryland; I-1, irrigated; Silty range site; Silty to Clayey woodland site.

Keith series

The Keith soils are friable and silty. They developed in deep, limy, flourlike loess or similar silty material (fig. 32). Their rather dark surface layer is 5 to 12 inches thick, granular in structure, and easily tilled. The moderately dark grayish to brownish subsoil is of blocky, or cloddy, structure and is slightly more clayey than the surface layer. The subsoil is 8 to 20 inches thick. The parent material is light-gray to pale-brown silty loess that contains much lime. In most places lime is within 24 inches of the surface.

The Keith soils developed under a cover of western wheatgrass, little bluestem, blue grama, buffalograss, and other mid and short grasses.

The Keith soils have more clearly defined layers and are less limy than the Colby and Ulysses soils. Keith soils have a blocky subsoil unlike that of the Colby soils and have a more strongly developed, darker subsoil than the Ulysses soils. Colors are not so dark or so deep as in the Goshen soils.

Typical profile of a Keith soil in a cultivated field on a slope of about 2 percent, 0.15 mile west and 50 feet north of the SE. corner of sec. 28, T. 4 N., R. 36 W.:

- A₁ 0 to 5 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine and very fine, granular or crumb structure; soft when dry, friable when moist; abrupt, smooth boundary.
- B₁ 5 to 13 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure separating to moderate, medium and fine, subangular blocky structure; hard when dry, friable when moist; clear, smooth boundary.
- B₂ 13 to 19 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure separating to moderate, medium and fine, subangular blocky structure; hard when dry, friable when moist; clear, smooth boundary.
- B₃ 19 to 24 inches, light brownish-gray (10YR 6/2.5) silt loam, grayish brown (10YR 4.5/2) when moist; weak, coarse, prismatic structure separating to weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; calcareous, with moderate amount of disseminated lime as well as spots of segregated white lime; clear, smooth boundary.
- C 24 to 36 inches +, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) when moist; massive; soft when dry, very friable when moist; calcareous, with abundant disseminated lime, and cracks, pores, and seams filled with white lime.

Keith fine sandy loam, 1 to 3 percent slopes (KfAW).—

This soil is associated with sandy soils of the uplands. Its profile is much like the one described for the Keith series, but its surface layer is fine sandy loam. Some of the organic matter and fine materials in the surface layer have been blown away.

This is good soil. Wheat, barley, rye, corn, sorghum, and vetch are suitable crops. Alfalfa is excellent under irrigation.

The main problems are protecting this soil from blowing, increasing the supply of moisture, and maintaining a balance between soil moisture and fertility. Use of stubble from small grains or other crops, stubble-mulch farming, and stripcropping help to conserve moisture, check blowing, and to maintain fertility. Crops respond to fertilizer, especially under a system that requires continuous cropping.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Keith fine sandy loam, 3 to 5 percent slopes, eroded (KfB2).—The profile of this soil is similar to the one described for the Keith series but the surface layer is fine sandy loam and the depth to the limy parent material is less. Also, the subsoil is a little lighter in color than in the profile described. Wind has blown some of the organic matter and fine materials from the surface layer. Water erosion has exposed subsoil and underlying material in a few places.

This is a fairly good soil. Wheat, corn, barley, rye, sorghum, and vetch are suitable crops. Alfalfa is an excellent crop under irrigation. The problems of managing this soil are the same as those on Keith fine sandy loam, 1 to 3 percent slopes, but they are harder to control because this soil is more sloping. Stubble-mulch farming, stripcropping, application of fertilizer, and use of crop residue are needed to control soil blowing and washing, to conserve moisture, and to maintain productivity.

Capability unit IIIe-3, dryland; IIIe-3, irrigated; Sandy range site; Sandy woodland site.

Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes (4Kf).—This nearly level soil is in upland valleys and is associated with sandy soils. Its profile is similar to the one described for the Keith series, but it developed from wind-worked materials derived from the Ogallala bedrock. The parent material, a silty to sandy deposit that weathered from the limy bedrock, is nearly white to olive and is soft to slightly indurated. Hard rock underlies this soil in a few places.

The dark surface layer is 8 to 15 inches of fine sandy loam; it is of granular structure and is easily tilled. The subsoil, 8 to 20 inches thick, contains slightly more clay than the surface layer and is of blocky, or cloddy, structure.

This is a good soil that is used mainly for crops. Under poor management, however, it is likely to blow and to lack fertility. Wheat, corn, sorghum, barley, rye, and grass are suitable crops. Alfalfa is a good crop under irrigation. Crops respond to careful use of fertilizer containing nitrogen, phosphorus, and possibly zinc. Fertilizer is especially needed if the soil is cropped continuously. Stubble mulching and growing of cover crops will control soil blowing, conserve moisture, and maintain the supply of organic matter.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes (4KfW).—This soil is similar to Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes, except that the wind has whipped its sandy surface layer. The soil is slightly undulating or wavy, partly because soil material recently scoured from open places has been deposited around fences and vegetation. Much of the fine material and the organic matter in the surface layer has blown away, and in places the upper part of this layer is a loamy fine sand.

This soil is cultivated. Wheat, rye, barley, sorghum, corn, sudangrass, vetch, and grass are suitable crops. Close-growing crops that produce stubble are needed to hold the soil in place and to add organic matter. Stubble-mulch farming and stripcropping help to control blowing. This soil responds to fertilizer containing nitrogen, phosphorus, and zinc.

Capability unit IIIe-3, dryland; IIIe-3, irrigated; Sandy range site; Sandy woodland site.

Keith fine sandy loam, thick, 0 to 1 percent slopes (2Kf).—This is a nearly level soil associated with sandy soils. Its profile is similar to that described for the Keith series, but it has thicker, dark layers.

The dark surface layer is fine sandy loam, 12 to 20 inches thick. It contains much organic matter, is granular, and is easily tilled. The dark subsoil, about 15 inches thick, is a loam or silt loam of weak, fine, blocky structure. In many places a dark, buried former surface layer lies below the present surface layer, and where this occurs the light-colored silty parent loess is at a considerable depth. Lime is 2 to 3 feet below the surface.

Most of this soil is cultivated. Good yields of wheat, corn, sorghum, barley, rye, and grass can be expected if blowing is controlled and there is a good supply of moisture. Alfalfa is an excellent irrigated crop. The soil is easily tilled, absorbs moisture readily, and stores

it well. Stubble crops and cover crops help to control blowing, to conserve moisture, and to maintain the content of organic matter. Crops respond to careful use of fertilizer.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Keith fine sandy loam, thick, 1 to 3 percent slopes (2KfA).—Like Keith fine sandy loam, thick, 0 to 1 percent slopes, this soil is suitable for wheat, corn, sorghum, barley, rye, and grass, and it needs the same management.

Capability unit IIe-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Keith silt loam, 1 to 3 percent slopes (KeAW).—The profile of this soil resembles the one described for the Keith series. This soil occurs mainly on the high upland divide in the eastern part of the county. Erosion has removed a moderate part of the original surface layer and of the organic matter. In many places that have been tilled, however, a part of the more clayey subsoil has been mixed with the surface layer.

Most of this soil is cultivated. The main problems are erosion, lack of moisture, and the need to maintain a balance between fertility and moisture. Use of terraces and keeping crop residue on the surface will help to conserve moisture and to maintain fertility. On the thin spots and seriously eroded places, crops respond to nitrogen fertilizer. This is especially true if cropping is continuous.

Capability unit IIe-1, dryland; IIe-1, irrigated; Silty range site; Silty to Clayey woodland site.

Keith silt loam, 3 to 5 percent slopes, eroded (KeB2).—The profile of this soil is not so deep, but it otherwise is much like that described for the Keith series. Also, lime is nearer the surface, and the subsoil is lighter in color and less clayey. In the more eroded places the lighter colored subsoil and underlying material have been exposed, mainly by water erosion. In places where this soil is near the sandy soils, the surface layer contains a little more sand and is a loam instead of silt loam. Small areas of Colby loam, 3 to 9 percent slopes, make up part of this mapping unit.

This is fairly good soil. Wheat, barley, rye, sorghum, and corn are suitable crops. The problems are the same as those on Keith silt loam, 1 to 3 percent slopes, but they are harder to control because of the stronger slopes. Terracing, stubble-mulch farming, contour stripcropping, and fertilizing are needed to control washing, conserve moisture, and maintain fertility.

Capability unit IIIe-1, dryland; IIIe-1, irrigated; Silty range site; Silty to Clayey woodland site.

Keith silt loam, caliche substratum, 0 to 1 percent slopes (4Ke).—This is a nearly level soil in low places in the upland valleys. It occurs with sandy soils. The profile is similar to that described for the Keith series, but this soil developed from wind-worked materials derived from the limy Ogallala bedrock. The parent material is a nearly white to olive, soft to slightly indurated, silty to sandy deposit that weathered from limy rock. Hard rock underlies this soil in a few places. Sand is under it in a few areas.

The dark surface layer is a silt loam, 8 to 15 inches thick, that is granular in structure and fairly stable. The subsoil, ranging from 8 to 20 inches in thickness, is slightly more clayey than the surface layer and is of

blocky structure. In places the surface layer contains a little sand and is of loam texture.

Almost all of this soil is cultivated. Wheat, sorghum, barley, rye, and corn are suitable crops. Alfalfa is an excellent irrigated crop. The main limitation on this soil is lack of rainfall, and the principal problem is maintaining a balance between fertility and moisture. The soil will blow occasionally. Crops respond to careful use of fertilizer containing nitrogen, phosphorus, and possibly zinc. Fertilizer is especially needed if crops are grown continuously.

Capability unit IIc-1, dryland; I-1, irrigated; Silty range site; Silty to Clayey woodland site.

Keith silt loam, thick, 0 to 1 percent slopes (2Ke).—This soil occurs mainly on the high tableland in the eastern part of the county. Its profile is similar to that described for the Keith series, though it has thicker, darker layers. The dark surface layer is 12 to 20 inches of silt loam that contains much organic matter, is granular, and is easily tilled. The dark subsoil, about 15 inches thick, is a silt loam of weak, fine, subangular blocky structure.

In many places a dark, buried, former surface layer is below the present surface layer, and the true light-colored, silty parent loess is at a considerable depth. Lime is $1\frac{1}{2}$ to 3 feet from the surface. Threads of white lime are common and evident in the dark, buried surface layer.

This is a good, fertile soil limited mainly by shortage of rainfall. Most of it is cultivated. Wheat, sorghum, barley, rye, and corn are suitable crops (fig. 33). The main problem is to maintain a balance between fertility and moisture.

Capability unit IIc-1, dryland; I-1 irrigated; Silty range site; Silty to Clayey woodland site.

Keith silt loam, thick, 1 to 3 percent slopes (2KeA).—Except for its occurrence in broad, very gently sloping areas and having a slightly thinner surface layer, this soil is similar to Keith silt loam, thick, 0 to 1 percent slopes. The surface soil ranges from about 12 to 16 inches in thickness.

This soil needs terraces to control water erosion and runoff. Contour stripcropping and stubble-mulch farm-

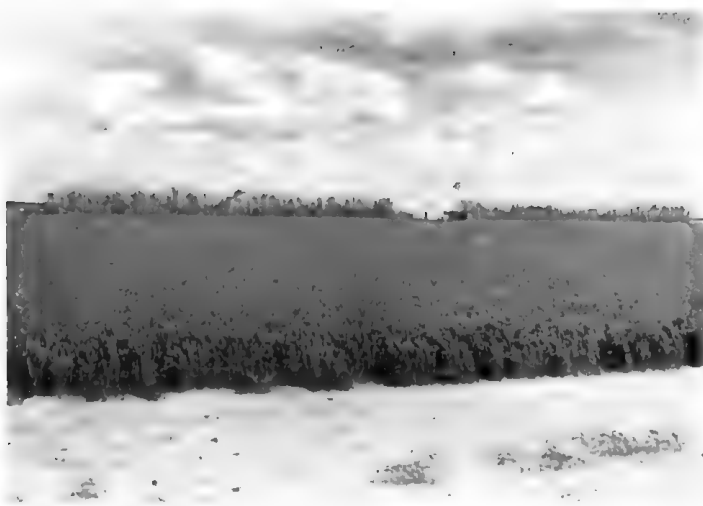


Figure 33.—Wheat on Keith silt loam, thick, 0 to 1 percent slopes, on the loess divide 16 miles north of Benkelman.

ing are other practices that break the long slopes and hold water on the soil. A balance between moisture and fertility is important if high yields of wheat, sorghum, barley, rye, and corn are to be obtained. Most of this soil is cultivated.

Capability unit IIe-1, dryland; IIe-1, irrigated; Silty range site; Silty to Clayey woodland site.

Las series

The Las series consists of nearly level, rather deep to moderately deep soils that formed in loamy material deposited over coarse river sediments. These soils are on bottom lands along the Republican River and its tributaries; the water table is 2 to 6 feet below the surface.

The rather light to moderately dark surface layer is 6 to 10 inches of loam of weak, granular structure. This layer contains lime and in places is strongly alkaline to strongly saline. The surface layer rests on layered, dark- and light-colored silty to slightly sandy materials that are, in places, alkaline or saline. Sandy sediments are at a depth of about 30 inches.

Las soils are more silty than the Las Animas soils, and they have a moderately high water table that does not occur in Havre soils.

The native vegetation on Las soils is a moderate stand of switchgrass, Indiangrass, big bluestem, and similar tall grasses. Moderate stands of western wheatgrass and other mid grasses grow in the drier areas. There is an abundant undergrowth of saltgrass in some places.

Typical profile of a Las soil in a pasture on a slope of less than 1 percent, 360 feet east and 150 feet north of SW. corner of NW¼ of sec. 16, T. 1 N., R. 37 W.:

- A₁ 0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown or dark grayish brown (10YR 3.5/2) when moist; compound, weak, coarse and medium, blocky (cloddy) structure that separates to weak, fine, granular; soft when dry, very friable when moist; calcareous, with slight amount of disseminated lime; mildly alkaline; abrupt, smooth boundary.
- C₁ 6 to 14 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak, very coarse and coarse, blocky (cloddy) structure; soft when dry, very friable when moist; calcareous, with moderate amount of disseminated lime; moderately alkaline; abrupt, smooth boundary.
- C₂ 14 to 21 inches, grayish-brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, blocky (cloddy) structure; soft when dry, friable when moist; calcareous, with moderate amount of disseminated lime; strongly alkaline, slightly saline; abrupt, smooth boundary.
- A_{1b} 21 to 24 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse and medium, blocky (cloddy) structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; strongly alkaline, slightly saline; clear, smooth boundary.
- C_{1b} 24 to 30 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, very coarse and coarse, blocky (cloddy) structure; slightly hard when dry, friable when moist; calcareous, with abundant disseminated lime; strongly alkaline, moderately saline; clear, smooth boundary.
- C_{2b} 30 to 36 inches, dark grayish-brown (10YR 4/2, moist) fine sandy loam; massive; few large and some small rustlike mottles; very friable when moist; calcareous, with moderate amount of disseminated lime; strongly alkaline, moderately saline; clear, smooth boundary.

- D 36 to 48 inches, brown (10YR 5/3, moist) coarse sand; single grain; few large and some small rustlike mottles; loose when moist; calcareous, with only very small amount of disseminated lime.

Salinity, alkalinity, and texture vary greatly in these soils. Some areas are not affected by salinity or alkalinity; other areas are almost severely affected. The salinity or alkalinity may be in the surface layer, in the silty deposits deeper down, or in the coarse river sands. The layers above the river sands range from very fine sandy loam to silty clay loam. The depth from the surface to the coarse sandy deposits ranges from 2 to 5 feet.

Las fine sandy loam, saline-alkali (2Is).—The profile of this soil is similar to the one described, except that the surface soil is not loam. Areas of Havre fine sandy loam and Laurel soils make up a small part of this soil. In a few places the sandy underlying sediments contain gravel.

The soil is easily managed and well suited to grass. It needs fertilizer, special treatment, and special crops if cultivated. Phosphorus is needed for almost all crops, and iron and zinc are needed for sorghum or corn. In places the water table may be so high as to interfere with tillage, especially during wet seasons. During dry and windy periods, the surface layer is likely to blow.

Alfalfa, grass, sugar beets, and barley are the best suited crops. Other small grains, corn, and sorghum may be grown on the drier sites and on the patches less affected by salts or alkali. Sugar beets should be grown only under irrigation.

Most of this soil is in pasture or hay, but a few areas are used for crops. Under irrigation, this soil possibly can be improved by frequent, shallow wetting with water of good quality. Such water, however, is hard to locate within the areas of this soil. Drainage is needed in most places, but it is hardly feasible or practical.

Capability unit IVs-1, dryland; IIIe-1, irrigated; Subirrigated range site; Moderately Saline-Alkali woodland site.

Las loam, saline-alkali (2It).—The profile of this soil is like that described for the series. In only a few places the sandy underlying sediments contain gravel. As mapped, this soil includes small areas of Havre loam, Platte loam, and Laurel soils.

This soil is easily managed if used for grass. Most of it is in pasture and hay. Only a few areas are cultivated, and these require fertilizer and special treatment. The most suitable cultivated crops are barley and sugar beets. Alfalfa is a good hay crop. This soil is less susceptible to blowing but otherwise requires management much like that for Las fine sandy loam, saline-alkali.

Capability unit IVs-1, dryland; IIIs-1, irrigated; Subirrigated range site; Moderately Saline-Alkali woodland site.

Las Animas series

The Las Animas series is made up of sandy, nearly level, moderately wet soils on bottom lands along the Republican River and its tributaries.

The surface layer is 6 to 10 inches of dark loamy fine sand that shows little structure. It contains much lime and, in some places, alkali salts. In a few places, a thin layer of loam underlies the surface layer. Ordinarily, however, the material under the surface layer is loamy

fine sand that contains strata of coarse, sandy sediments. Two feet or more from the surface are sandy sediments stained or spotted with blue, olive, gray, and rust colors in the part affected by the water table.

The Las Animas soils have a moderately high water table that does not occur in the Banks and Havre soils, and they are more sandy than the Las soils. Las Animas soils have a darker and thicker surface layer than Sandy alluvial land, and they formed in more uniform sandy materials.

The native vegetation is Indiangrass, big bluestem, switchgrass, and other tall grasses, with an understory of saltgrass.

Typical profile of a Las Animas soil in a cultivated field on a slope of less than 1 percent, 100 feet east, 0.15 mile north of SW. corner of sec. 17, T. 1 N., R. 40 W.:

- A₀ 0 to 6 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; single grain; loose when dry, loose when moist; calcareous, with abundant disseminated lime; moderately alkaline; clear, smooth boundary.
- A₁ 6 to 8 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; single grain; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; moderate to strongly alkaline; clear, smooth boundary.
- AC 8 to 13 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; single grain; loose when dry, loose when moist; calcareous, with abundant disseminated lime; moderate to strongly alkaline; gradual, wavy boundary.
- C₁ 13 to 26 inches, light-gray (10YR 7/2) sand, light brownish gray or grayish brown (10YR 5.5/2) when moist; single grain; loose when dry, loose when moist; calcareous, with abundant disseminated lime; slightly alkaline; abrupt, smooth boundary.
- C₂ 26 to 40 inches, dark grayish-brown (2.5Y 4/2, moist) loam; thin lenses of sand and fine sandy loam; massive; very friable when moist; numerous, faint, large spots, or mottles, of olive gray (5Y 4/2); calcareous, with very small amount of disseminated lime; clear, smooth boundary.
- C₃ 40 to 50 inches, olive-gray (5Y 4/2, moist) fine sandy loam; massive; very friable when moist; noncalcareous; high water table.

Las Animas loamy fine sand (ln).—This is the only Las Animas soil in the county. Its profile is that described for the Las Animas series.

This soil is excellent for grasses. Most of it is used for native hay or pasture, and good yields can be expected in most years. It is poor to fair for cultivated crops, and few areas are cultivated. In wet years the crops may drown out, and in dry years organic matter is burned up and the soil blows severely. If cultivated crops are grown, the soil needs nitrogen, phosphorus, and possibly zinc. Alfalfa and sugar beets are best suited among the crops requiring regular or infrequent cultivation.

Capability unit IVw-5, dryland; IVw-5, irrigated; Subirrigated range site; Moderately Wet woodland site.

Laurel series

The Laurel series consists of nearly level, very strongly alkaline or saline soils that formed in deep, silty to slightly sandy sediments on bottom lands of the Republican River (fig. 34). The water table is 2 to 8 feet from the soil surface.



Figure 34.—Laurel soils contain concentrations of salt or alkali that limit the moisture available to plants.

The surface layer is 4 to 10 inches of dark loam of granular structure. The silty subsoil is very strongly alkaline and moderately saline. Lime is scattered throughout the soil.

The native vegetation consists of a thick stand of saltgrass, a moderate growth of alkali sacaton and western wheatgrass, and in places, a scattering of switchgrass.

Typical profile of a Laurel soil in a pasture on a slope of less than 1 percent, 0.1 mile east and 100 feet north of the center of sec. 24, T. 1 N., R. 38 W.:

- A₁₁ 0 to 1 inch, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, very fine, crumb structure; soft when dry, very friable when moist; calcareous, with only very small amount of disseminated lime; moderately alkaline; abrupt, smooth boundary.
- A₁₂ 1 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse and medium, blocky (cloddy) structure separating to weak, fine and very fine, granular structure; soft when dry, very friable when moist; calcareous, with only very small amount of disseminated lime; moderately alkaline; abrupt, smooth boundary.
- A₁₃ 5 to 10 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure separating to moderate, medium and fine, blocky structure; hard when dry, friable when moist; calcareous, with moderate amount of disseminated lime; very strongly alkaline, moderately saline; abrupt, smooth boundary.
- A₁₄ 10 to 12 inches, very dark gray (10YR 3/1) loam, very dark brown (10YR 2/2) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, friable when moist; calcareous, with moderate amount of disseminated lime; very strongly alkaline, moderately saline; clear, smooth boundary.
- AC₆ 12 to 18 inches, grayish-brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, very friable when moist; calcareous, with moderate amount of disseminated lime; very strongly alkaline, moderately saline; gradual, smooth boundary.
- C₆₁ 18 to 34 inches, grayish-brown (10YR 5/2, moist) very fine sandy loam; weak, coarse, blocky structure; very friable when moist; calcareous, with moderate amount of disseminated lime; very strongly alkaline, moderately saline; clear, smooth boundary.

- C_{1b2} 34 to 39 inches, grayish-brown (10YR 5/2, moist) loam; massive; friable when moist; calcareous, with abundant disseminated lime; strongly alkaline, moderately saline; few, faint, small, brown spots or mottles; clear, smooth boundary.
- C_{1b3} 39 to 42 inches, brown (10YR 5/3, moist) very fine sandy loam; massive; very friable when moist; calcareous, with abundant disseminated lime; strongly alkaline, moderately saline; few, faint, small, brown spots or mottles; abrupt smooth boundary.
- C_{1b4} 42 to 44 inches, grayish-brown (10YR 5/2, moist) silt loam; massive; friable when moist; calcareous, with abundant disseminated lime; strongly alkaline, moderately saline; abrupt, smooth boundary.
- C_{1b5} 44 to 50 inches, grayish-brown (10YR 5/2, moist) fine sandy loam; massive; very friable when moist; calcareous, with abundant disseminated lime; strongly alkaline, moderately saline; contains water.

The amount of soluble salts and alkali in Laurel soils varies from place to place and in depth from the surface. The underlying materials range from fine sandy loam to silty clay loam. The sediments deeper down are normally coarser river deposits.

Laurel soils (LS).—In this mapping unit are Laurel soils having profiles much like the one described for the series. Their total acreage is not large, and in many places they occur as small patches within areas of other soils on the bottom lands.

The surface layer ranges from fine sandy loam to silty clay loam. In some places the surface is crusted because of the high content of sodium. Eyes, or spots, of salts appear within these soils in some places, but where these concentrations do not contain sodium, the soil is well granulated and not crusted.

This mapping unit contains small areas of Las fine sandy loam, saline-alkali, and of Las loam, saline-alkali.

The soils of this mapping unit are most suitable for grass. Tall wheatgrass, reed canarygrass, and alkali-tolerant grasses grow best. Possibly alkali-tolerant legumes can be grown.

Capability unit VI₁—1, dryland; Saline Lowland range site; not suitable as a site for planting trees.

Ovina series

The Ovina soils developed in deep, soft, silty material weathered from the Ogallala formation. They have a sandy surface layer, contain lime, and have a moderately high water table. They are in nearly level upland valleys, mainly in the northwestern part of the county.

The rather dark surface layer is about 6 to 12 inches of sandy material that has granular structure and contains much lime. The underlying silty material is white, gray, or olive; it contains some snail shells, is limy, and in the lower part is wet because of the water table.

Ovina soils have a silty substratum, as contrasted to the sandy substratum of the Elsmere soils. They are more silty and limy than the Dunday soils, and have a higher water table.

The native vegetation on Ovina soils is switchgrass, Indiangrass, big bluestem, and other tall prairie grasses, with an undergrowth of saltgrass.

Typical profile of an Ovina soil in a native pasture on a slope of less than 1 percent, 0.3 mile north and 0.1

mile west of the SW. corner of the SE $\frac{1}{4}$ of sec. 1, T. 4 N., R. 42 W.:

- A₁ 0 to 6 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; moderately alkaline; clear, smooth boundary.
- B 6 to 16 inches, gray (5Y 5.5/1) loam, dark gray (10YR 4/1) when moist; compound, weak, coarse, prismatic structure separating to weak, fine, granular structure; slightly hard when dry, friable when moist; calcareous, with abundant disseminated lime; moderately alkaline; clear, smooth boundary.
- C 16 to 24 inches, light-gray (5Y 7/1) silt loam, gray (5Y 5/1) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist; calcareous, with abundant disseminated lime; moderately alkaline; few small snail shells; clear, smooth boundary.
- D 24 to 48 inches, white (5Y 8/2) fine silt loam, light olive gray (5Y 6/2) when moist; massive; hard when dry, friable when moist; calcareous, with abundant disseminated lime; mildly alkaline.

The white, weathered parent material occurs near the surface in some areas and is rather far down in others. The soils contain a few spots that are very strongly alkaline.

Ovina soils are well suited to grass and are easily managed if used for permanent pasture or hay. Alfalfa is the best crop if the soils are cultivated. Tall wheatgrass and reed canarygrass are good grasses to grow. Good hay crops can be expected in most years because the water table supplies moisture. The soils are poor to fair for cultivation. Crops may drown out in wet years, and in dry years the organic matter burns up and the soils blow.

Ovina fine sandy loam, 0 to 1 percent slopes (Ov).—This is the only Ovina soil mapped in the county. Its profile is like the one described for the Ovina series. This soil is used mainly to grow native or tame grasses for pasture or hay. It is well suited to this use.

Capability unit IV_w—6, dryland; III_w—6, irrigated; Subirrigated range site; Moderately Wet woodland site.

Platte series

The Platte series consists of shallow, wet soils occurring in low, half-moon-shaped or long, narrow areas adjacent to the Republican River and other major streams. The soils occupy old stream channels that have been filled with sediment. They have a thin, loamy surface layer over coarse sand and gravel. The water table is moderately high or high.

The surface layer is about 8 inches of moderately dark loam that contains much lime. The underlying material is either clean coarse sand or a mixture of coarse sand and gravel.

The Platte soils differ from the Rauville soils in having coarse underlying material. They are shallower and slightly wetter than the Las soils. They differ from the Las Animas soils in having coarse sand and gravel in the underlying material, instead of loamy fine sand or fine sand.

The native vegetation on Platte soils is prairie cordgrass, switchgrass, Indiangrass, and other coarse prairie grasses, along with scattered stands of willows and other trees or shrubs.

Typical profile of a Platte soil in a native hay meadow on a slope of less than 1 percent, 0.25 mile south and 300 feet east of the NW. corner of sec. 28, T. 1 N., R. 38 W.:

- A₁ 0 to 2 inches, very dark grayish-brown (10YR 3/2, moist) loam; matted with roots; weak, fine, crumb structure; very friable when moist; calcareous, with abundant disseminated lime; moderately alkaline; clear, smooth boundary.
- AC 2 to 8 inches, dark grayish-brown (10YR 4/2, moist) loam with thin lenses of sand and silt; weak, fine, granular structure; very friable when moist; calcareous, with abundant disseminated lime; moderately alkaline; clear, wavy boundary.
- C 8 to 12 inches, dark-brown (10YR 4/3, moist) sandy loam; massive; very friable when moist; calcareous, with moderate to slight amount of disseminated lime; mildly alkaline; abrupt, wavy boundary.
- D 12 to 30 inches \mp , coarse sand and gravel; high water table.

The surface layer ranges from loam to silty clay loam, and the depth to the underlying coarse sand and gravel is 6 inches to 2 feet.

Platte loam (Pl).—This is the only soil of the Platte series mapped in the county. Its profile is like that described for the series.

The areas of this soil are along major streams and are subject to overflow. A typical location is in an oxbow in an abandoned river channel filled with fine-textured sediments (fig. 35).

This soil is associated with Sandy alluvial land and is used mainly for pasture. It is too wet and too shallow for cultivated crops. Coarse grasses grow well, however, and the soil can be improved for meadows.

Included with this soil are areas where the water table is deep. Such areas are drier than those nearby and support western wheatgrass and blue grama. In some places salts have accumulated in the surface layer.

Capability unit Vw-1, dry; Subirrigated range site; Wet woodland site.

Rauville series

In the Rauville series are deep, dark, wet, nearly level, silty soils on bottom lands.

The surface layer, ranging from about 8 to 12 inches in thickness, is matted with roots and has an accumulation of organic matter in its upper part. This layer con-

tains much lime and variable amounts of soluble salts. The dark material below the surface layer consists of dark-colored, silty to slightly sandy sediments, which occur in strata of different texture and contain no lime.

The Rauville soils are darker and deeper than the Platte soils, and are silty to slightly sandy in the underlying layers, rather than coarse sandy or gravelly. Rauville soils resemble the Gannett soils, but are silty instead of sandy, and are on bottom lands instead of uplands.

The native vegetation on Rauville soils is a rank growth of prairie cordgrass and water-tolerant plants.

Typical profile of a Rauville soil in a native meadow on a slope of less than 1 percent, 0.17 mile or 900 feet north of the SE. corner of sec. 12, T. 1 N., R. 42 W.:

- A₀ 0 to 5 inches, dark grayish-brown (10YR 4/2, moist), matted organic loam; nonsticky when wet; calcareous, with abundant soluble lime; moderately saline; gradual, smooth boundary.
- A₁ 5 to 12 inches, very dark gray (10YR 3/1, moist) silt loam; weak, coarse, prismatic structure; very sticky when wet; calcareous, with abundant soluble lime; moderately saline; clear, wavy boundary.
- C₁ 12 to 16 inches, dark grayish-brown (2.5Y 4/2, moist) loam; massive; sticky when wet; clear, smooth boundary.
- C₂ 16 to 20 inches, very dark gray (10YR 3/1, moist) fine sandy loam; massive; slightly sticky when wet; noncalcareous; abrupt, smooth boundary.
- C₃ 20 to 23 inches, very dark grayish-brown (2.5Y 3/2, moist) coarse fine sandy loam; massive; many faint, olive-brown (2.5Y 4/4) mottles; slightly sticky when wet; clear, smooth boundary.
- C₄ 23 to 28 inches, very dark gray (2.5Y 3/0, moist) fine sandy loam; massive; few, faint, olive-gray (5Y 4/2) mottles; slightly sticky when wet; gradual, smooth boundary.
- C₅ 28 to 48 inches, very dark gray (2.5Y 3/0, moist) loam; massive; sticky when wet; noncalcareous.

The surface layer and the upper part of the C horizon range from loam to silt loam or silty clay loam. The lower part of the C horizon is slightly more sandy than the upper; the range is from fine sandy loam to loam or silt loam. The content of soluble salts ranges from low to high.

Rauville loam (Ra).—This is the only soil of the Rauville series mapped in the county. It occurs mainly on the North Fork Republican River, west of Haigler. Other areas, however, are on narrow bottom lands along the smaller flowing streams.

The profile of this soil is like that described for the Rauville series. Slopes vary slightly, and there are a few cradle knolls. The water table is near the surface, except where it is under the higher knolls. Included are small areas of Las loam, saline-alkali.

This soil is best suited to hay or pasture and is used for that purpose.

Capability unit Vw-1, dryland; Wet Land range site; Wet woodland site.

Rough broken land

Two kinds of Rough broken land are mapped in this county, Rough broken land, caliche, and Rough broken land, loess. These miscellaneous land types occur in very steep places where slopes break abruptly toward drainage channels. Much water runs from such slopes, and erosion is active.

Rough broken land, caliche (BCa).—About half of this miscellaneous land type is barren, hard caliche and sand-



Figure 35.—Platte loam supports coarse grasses and scattered to thick stands of willows or other brush.



Figure 36.—Rough broken land, loess, in southwestern part of Dundy County.

stone of the Ogallala formation or other Tertiary formation. The rest consists of very shallow, sparsely vegetated soils on upper slopes and of deep pockets of soil among the rock outcrops.

This land occurs near the heads of Rock and Buffalo Creeks and in Rock Canyon. All the drainageways are fed by seeps or springs. The land provides protection for livestock and wildlife but is of little value for grazing or trees.

Capability unit VII_s-3, dryland; Thin Breaks range site; not suitable as woodland.

Rough broken land, loess (BL).—This land type consists of silty and limy loess or of similar deep, soft material that has been cut by many small channels or drainageways (fig. 36).

Soil slipping is common, as is evidenced by a succession of "catsteps," or short, vertical exposures of raw material on the broken slopes. Runoff is rapid. Where it has not been removed by erosion, the surface layer is thin and dark colored. The underlying material is silty, light colored, and limy. Where stream channels have cut through geologic formations, hard caliche, shale, sand, or gravel is exposed.

This land is associated with Colby loam, 9 to 30 percent slopes, in canyons along drainageways to the Republican River. It includes small areas of Colby soil and of Broken alluvial land.

The native vegetation is mid and short grasses and scattered yucca plants. Western wheatgrass grows in the protected areas, and side-oats grama, little bluestem, blue grama, and buffalograss are on the steep, exposed slopes. This land is used for grazing.

Capability unit VII_e-1, dryland; Thin Loess range site; Silty to Clayey woodland site.

Scott series

The Scott series consists of deep, dark, sticky, clayey soils that occupy small, basinlike depressions in the uplands.

The surface layer is black, silty, granular, and about 6 inches thick. The subsoil is black, thick, sticky, clayey,

and blocky. The underlying material is silty and lighter in color than the layers above it. Scott soils contain no free lime.

Scott soils, the only true claypan soils in the county, are in positions similar to those occupied by Gannett soils. The Gannett soils, however, are sandy and have a high water table.

The vegetation on Scott soils is sparse, and many areas are barren. Bur-ragweed, a noxious weed, is common. A growth of annual smartweed, sunflower, and western wheatgrass covers these soils in dry years, but in wet years these plants are confined mainly to the edges of the depressions.

Typical profile of a Scott soil in an idle area, almost barren of vegetation, with a slope of less than 1 percent, 0.25 mile east of the NW. corner of sec. 29, T. 4 N., R. 36 W.:

- A_D 0 to 2 inches, light brownish-gray (10YR 6/2), dust-mulch silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, platy structure separating to weak, very fine, granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.
- A₁ 2 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; abrupt, smooth boundary.
- B₁₁ 6 to 18 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; weak, very coarse, prismatic structure separating to strong, medium and fine, angular, blocky structure; very hard when dry, very fine when moist; clear, smooth boundary.
- B₂₂ 18 to 40 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; weak, coarse, prismatic structure separating to moderate, medium, angular, blocky structure; very hard when dry, very firm when moist; clear, smooth boundary.
- B₂₃ 40 to 54 inches, gray or dark-gray (10YR 4.5/1) silty clay loam, very dark brown (10YR 2/2) when moist; weak, coarse and medium, angular, blocky structure; hard when dry, firm when moist; gradual, smooth boundary.
- C 54 to 70 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; layered with dark grayish-brown (10YR 4/2, moist) silt loam; massive; slightly hard to soft when dry, friable when moist.

Scott silt loam (Sc).—This is the only Scott soil mapped in the county. It is in potholes scattered through the more nearly level uplands in the eastern part of the county. During wet periods runoff from the nearby Keith soils fills the potholes, and they then resemble lagoons. The water disappears slowly through seepage and evaporation, and during the dry season the surface is crusted and cracked.

Ordinarily, this soil is pastured with other soils or left idle. A few areas may be cultivated during the dry season.

Capability unit VI_w-1, dryland; Overflow range site; Wet woodland site.

Ulysses series

The Ulysses series is made up of friable silty soils of the uplands that developed from deep, limy loess.

The moderately dark silty surface layer is 5 to 10 inches thick, is of granular structure, and is easily tilled. The moderately light colored subsoil contains much lime, is blocky, or cloddy, and is 5 to 15 inches thick. The parent material is light-gray, silty loess that contains much finely divided lime.

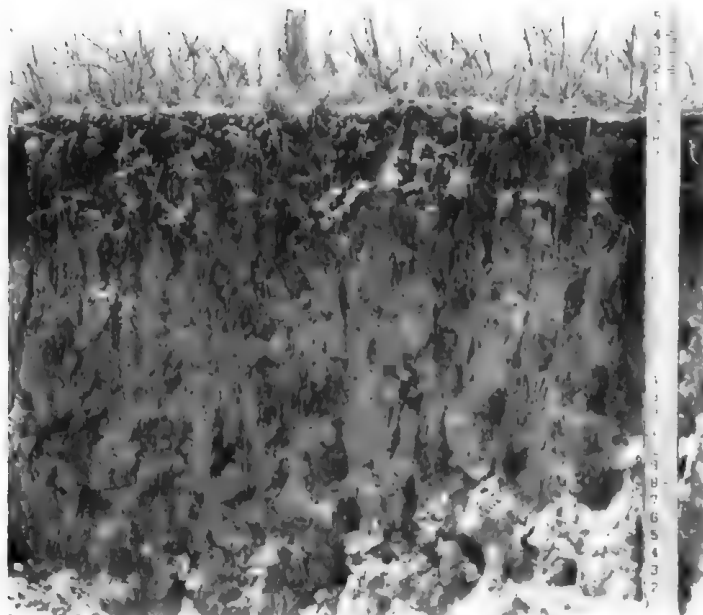


Figure 37.—Profile of Ulysses silt loam showing 8- to 9-inch surface layer clearly grading to the lighter colored, limy subsoil and parent material.

Ulysses soils somewhat resemble both the Keith and Colby soils. They are darker, more developed, and less limy than the Colby soils, and they differ in having a blocky subsoil. The Ulysses soils have a lighter colored, more limy subsoil than the Keith soils (fig. 37).

Ulysses soils developed under a cover of western wheat-grass, blue grama, side-oats grama, and other mid and short grasses.

Typical profile of Ulysses soil in a cultivated field on a slope of about 7 percent, 0.1 mile east, 500 feet south of NW. corner of sec. 32, T. 4 N., R. 37 W.:

- A_p 0 to 4 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, very fine granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.
- A₁ 4 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, blocky (cloddy) structure separating to weak, fine and very fine, granular structure; slightly hard when dry, friable when moist; occasional worm casts; clear, wavy boundary.
- B₂₁ 7 to 12 inches, grayish-brown (10 YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure separating to weak, medium and fine, blocky structure; hard when dry, friable when moist; occasional worm casts; calcareous with an abundance of disseminated lime, a few spots of lime, and lime-coated worm casts; clear, smooth boundary.
- B₂₂ 12 to 18 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure separating to weak, fine, sub-angular blocky structure; slightly hard when dry, friable when moist; calcareous with abundance of disseminated lime; white lime fills cracks and pore spaces; gradual, smooth boundary.
- C 18 to 48 inches, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) when moist; massive (structureless); soft when dry, very friable when moist; calcareous with an abundance of disseminated lime and a few spots and threads of white lime.

Ulysses silt loam, 5 to 9 percent slopes (UsC).—This soil is on sloping or rolling loess uplands in the eastern and southern parts of the county. Its profile is similar

to the profile described for the Ulysses series, except that the surface layer is slightly thicker, or about 10 inches thick. Small areas of Colby loam, 3 to 9 percent slopes, of Colby loam, 9 to 30 percent slopes, and of Bridgeport loam, 3 to 5 percent slopes, were included in mapping this soil.

This soil is mainly in pasture, and it responds to good management. It can be cultivated, but it is poor to fair for crops. Erosion and fertility are serious problems under cultivation. Wheat, rye, barley, and other small grains are the crops best suited.

Capability unit IVE-1, dryland; IVE-1, irrigated; Silty range site; Silty to Clayey woodland site.

Ulysses silt loam, 5 to 9 percent slopes, eroded (UsC2).—The profile of this soil is like the profile described for the series. The surface layer is about 5 to 7 inches thick.

Small areas of Colby loam, 3 to 9 percent slopes, of Colby loam, 9 to 30 percent slopes, and of Bridgeport loam, 3 to 5 percent slopes, were included in mapping this soil.

Most of the soil is cultivated, and a moderate amount of the surface layer has been removed by sheet and rill erosion. The steepness of the slopes causes a serious hazard of erosion, and the thinness of the surface layer creates a problem in fertility. Intensive treatment and extreme care are needed to control erosion and to conserve moisture.

This soil is poor to fair for crops. Corn and other row crops add little organic matter and encourage rapid soil washing. Wheat, rye, and barley are the best suited crops.

Capability unit IVE-1, dryland; IVE-1, irrigated; Silty range site; Silty to Clayey woodland site.

Ulysses series, clay substratum variant

The clay substratum variants of the Ulysses series are soils that have a loamy surface layer and a silty to moderately fine textured subsoil. They are like the other Ulysses soils but have a finer textured, browner subsoil and substratum. These soils developed in a mixture of silty loess and clay shale. They are on the lower slopes of uplands, along the valley of the Republican River. These soils are gently sloping to sloping and are moderately deep to deep over weathered, platy shale.

The moderately dark loam surface layer is 6 to 10 inches thick; it is of granular structure and is easily tilled. The subsoil is brownish, has a blocky structure, contains many soft concretions of lime, and is more clayey than the surface layer. The underlying material is platy shale.

These soils formed under a cover of western wheat-grass, side-oats grama, blue grama, and other mid and short grasses.

Typical profile of a Ulysses loam, clay substratum variant, in a cultivated field on a slope of 4 percent, 0.1 mile south and 0.25 mile west of NE. corner of SE $\frac{1}{4}$ of sec. 27, T. 1 N., R. 40 W.:

- A_p 0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, very fine, granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.
- A₁ 4 to 9 inches, grayish-brown (10YR 5/2) loam, dark grayish brown or very dark grayish brown (10YR 3.5/2) when moist; weak, coarse, blocky (cloddy) structure separating to weak, medium and fine, granular

structure; soft when dry, friable when moist; clear, smooth boundary.

- B₁ 9 to 13 inches, grayish-brown (10YR 5/2), coarse-textured clay loam, dark grayish brown to brown (10YR 4/2.5) when moist; weak, medium and fine, blocky structure; hard when dry, friable when moist; calcareous, with abundant disseminated lime; clear, smooth boundary.
- B₂₁ 13 to 18 inches, light olive-brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) when moist; weak, medium, blocky to weak, fine and very fine, blocky structure; hard when dry, friable when moist; calcareous, with abundant disseminated lime, as well as several small soft spots or concretions of white lime; gradual, wavy boundary.
- B₂₂ 18 to 28 inches, light yellowish-brown (2.5Y 6/3) silty clay loam, light olive brown or olive brown (2.5Y 4.5/4) when moist; weak, coarse, blocky structure separating to weak, fine, subangular blocky structure; hard when dry, firm when moist; few, small, shale fragments; calcareous, with abundant disseminated lime as well as several, small, soft spots or concretions of white lime; gradual, wavy boundary.
- C 28 to 38 inches, light yellowish-brown (2.5Y 6/3) silty clay, light olive brown or olive brown (2.5Y 4.5/4) when moist; massive; very hard when dry, firm when moist; many distinct shale fragments; calcareous, with abundant disseminated lime, as well as several, small, soft spots or concretions of white lime; clear, smooth boundary.
- D 38 to 50 inches, weathered, platy clay shale with some crystalline salts. Bedded shale is 2 to 5 feet from the surface.

Under cultivation, these variants of the Ulysses series are best suited to wheat, barley, rye, and sorghum. Good yields of wheat and sorghum can be expected when nitrogen and phosphorus are added and the content of organic matter in the surface layer is maintained. Corn yields are uncertain because these soils are droughty and rainfall is limited. Alfalfa and grass are good crops under irrigation. All crops respond if runoff and erosion are controlled by terracing, contour farming, and returning crop residue to the soil.

Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded (2UC2).—This gently sloping soil occurs mainly on the lower parts of the uplands. It is on the south side of the Republican River, west of Benkelman, and westward to the Colorado State line. The profile is like the one described for the variants of the Ulysses series.

Included with this soil are small areas of Ulysses silt loam, 5 to 9 percent slopes, and of Bridgeport loam, 3 to 5 percent slopes.

Most of this soil is cultivated, and sheet and rill erosion are serious problems.

Capability unit IIIe-1, dryland; IIIe-1, irrigated; Silty range site; Silty to Clayey woodland site.

Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded (2UC3).—This soil is on uplands in the southwestern part of the county, where it is associated with Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded. It is similar to that soil except that the original surface layer has eroded away and the clay loam subsoil has been exposed. This soil, therefore, is thinner to the bedded shale. Sheet and gully erosion are serious problems.

This soil is cultivated or it has been cultivated and returned to pasture. It is best suited to grass and permanent pasture.

Capability unit VIe-1, dryland; Silty range site; Silty to Clayey woodland site.

Valentine series

The soils of the Valentine series are deep, loose, and sandy. They develop from lime-free eolian sand. They are the major soils on the sandhills of the uplands, where they occur on a succession of sand ridges, dunes, mounds, and hummocks.

The slightly darkened, very sandy surface layer is 6 to 10 inches thick; it has very weak, granular structure but separates easily to single grains. This layer grades to the grayish, brownish, or yellowish-brown, loose sand of the parent material. There is no free lime.

Though Valentine soils have accumulated organic matter sufficient to darken and stabilize the surface layer, they are thinner, lighter in color, and more sandy than the Anselmo soils. Also, they lack the blocky subsoil of the Anselmo soils. Valentine soils have a thinner and lighter colored surface layer than the Dunday soils, which occur in nearby or adjoining, nearly level valleys.

The native vegetation is a moderate growth of prairie sandreed, switchgrass, sand bluestem, big bluestem, little bluestem, sand dropseed, needle-and-thread, blue grama, and other tall, mid, and short grasses. Sand sagebrush is common in some areas.

Typical profile of a Valentine soil in a pasture on a smooth sand hummock with a slope of about 6 percent, 100 feet west and 100 feet south of NE. corner of sec. 18, T. 3 N., R. 37 W.:

- A₁ 0 to 7 inches, grayish-brown or dark grayish-brown (10YR 4.5/2) fine sand, dark brown or very dark grayish brown (10YR 3/2.5) when moist; few, weak, large clods but mainly very fine, granular structure that tends to separate to single grains; loose when dry, loose when moist; gradual, smooth boundary.
- AC 7 to 12 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) when moist; few, very weak clods but mainly single grains; loose when dry, loose when moist; gradual, smooth boundary.
- C 12 to 30 inches +, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; single grains, loose when dry, loose when moist.

Through accumulation of fine dust particles, the Valentine soils may have surface crusts, 1/4 to 1 inch thick, of very fine sandy loam to loamy fine sand.

The Valentine soils are suitable only for grass, trees, or wildlife because they are low in fertility, are droughty, and blow severely when disturbed.

Valentine fine sand, hilly (VaD).—The profile of this soil is similar to the profile described for the Valentine series, but the soil is on high, rugged, choppy, dished-out sand hummocks, or dunes. Also, the surface layer is a little lighter in color, is less stable, and is thinner, or about 2 to 5 inches thick. A few of the high caps of the hills are pitted by small blowouts.

This soil is extensive in the northwestern part of the county. Small areas of Valentine fine sand, rolling, are mapped with it, as are small areas of Blown-out land.

This soil is suitable only for grasses and grazing, or for wildlife. It is used as rangeland. Grasses and sage form a sparse to moderate cover. The amount and kind of cover depend partly upon past use and management. Grasses respond to good management that includes putting the proper number of livestock on the range, rotation and resting of range, and distribution of water and salt. Soil blowing is a serious problem.

Capability unit VIIe-5, dryland; Choppy Sands range site; Very Sandy woodland site.

Valentine fine sand, rolling (VaC).—The profile of this soil is similar to the one described for the Valentine series. The soil is in the northwestern part of the county on hummocky, rolling, and rounded hills. It is the most extensive soil in the county.

Areas of Valentine fine sand, hilly, Blown-out land, and Valentine loamy fine sand make up only a small part of the area of this soil.

Most of the soil is used for pasture. Some areas were once cultivated, and the surface layer was then slightly pitted and shifted back and forth by the wind. Now, these areas are stabilized by weeds and grasses. Native grasses respond to good range management, including putting the proper number of livestock on the range, protection from overgrazing, reseeding, and distribution of salt and water. Wind erosion is a serious hazard.

Capability unit VIe-5, dryland; Sands range site; Very Sandy woodland site.

Valentine loamy fine sand (Vb).—This soil is similar to Valentine fine sand, rolling, but it is more silty and a little more stable. Its profile is similar to the one described for the Valentine series, except the surface layer, especially, is more silty. The surface layer is loamy fine sand instead of fine sand. This soil occurs on undulating to smooth and rolling slopes around the edges of the Anselmo, Keith, and Colby soils. It grades to areas of Valentine fine sand, rolling.

Most of this soil is used for rangeland and pasture, but several areas are cultivated. They have been subjected to different degrees of soil blowing and wind erosion and are pitted by a few, scattered, small blowouts. Many of these areas have been abandoned as farmland and are covered with various kinds of weeds and grasses. Areas of Valentine fine sand, rolling; Anselmo loamy fine sand, 3 to 5 percent slopes; Anselmo fine sandy loam, 5 to 9 percent slopes; and Blown-out land make up a small part of this soil. Anselmo loamy fine sand, 0 to 3 percent slopes, and Dunday loamy fine sand, on isolated swales and flats between the more rolling hills, are also included.

Forage grasses respond to good pasture management, including proper numbers of livestock, reseeding, resting of pastures, and distribution of salt and water. Wind erosion is a serious hazard.

Capability unit VIe 5, dryland; Sands range site; Very Sandy woodland site.

Vebar series

The Vebar series consists of level to gently sloping, rather dark, moderately sandy soils that overlie bedrock.

The rather dark surface layer is 10 to 14 inches of fine sandy loam that has weak, granular structure. The underlying material is lighter colored fine sandy loam that rests on bedrock of the Ogallala formation. Lime occurs below the surface layer, and a few pebbles or small rock fragments are scattered through these soils.

The Vebar soils are similar to the Anselmo soils but have a more uniform content of lime and are on hard rock. They resemble the Canyon soils but are deeper to bedrock.

The native vegetation on Vebar soils is mainly western wheatgrass, side-oats grama, blue grama, and other mid and short grasses.

Typical profile of a Vebar fine sandy loam, moderately deep, in a pasture on a slope of less than 1 percent, 0.25 mile south of NW. corner of sec. 27, T. 2 N., R. 41 W.:

- A₁₁ 0 to 1 inch, dark grayish-brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.
- A₁₂ 1 inch to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, very coarse and coarse, prismatic structure separating to weak, fine, granular structure; soft when dry, very friable when moist; gradual, smooth boundary.
- AC 12 to 17 inches, grayish-brown (10YR 5/2) fine sandy loam containing a few pebbles and a few small rock fragments, dark grayish brown (10YR 3.5/2) when moist; weak, coarse, prismatic structure separating to weak, fine, granular structure; soft when dry, very friable when moist; calcareous, with abundant disseminated lime; clear, wavy boundary.
- C_{ea} 17 to 28 inches, light brownish-gray (10YR 5.5/2) loamy fine sand, grayish brown (10YR 4.5/2) when moist; few lime rock fragments ½ inch to 1½ inches in diameter and scattered smaller rock fragments and pebbles; massive; loose when dry, very friable when moist; calcareous, with abundant disseminated lime, many white lime spots; abrupt, wavy boundary.
- D 28 to 36 inches +, white (10YR 8/1), only slightly weathered, Ogallala limestone and sandstone.

The thickness above bedrock ranges from about 16 to 36 inches. Lime is near the surface in some places and as much as 16 inches below the surface in others.

Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes (3Vfa).—This soil, the only member of the Vebar series mapped in the county, has the profile described for the series. The soil is on high flats or in upland valleys where the bedrock has not been deeply covered by eolian sand.

Included with this soil in mapping are cultivated areas that have a surface layer of loamy fine sand. Also included are spots where rock crops out.

This soil is cultivated or in pasture. If cultivated, it is best suited to wheat, rye, barley, sorghum, and similar shallow-rooted crops. It is subject to blowing, and crops that provide stubble or fibrous roots help to check this. Response of crops to phosphorus and nitrogen is good, as is the response to practices that conserve moisture. Sorghum tends to yellow in places where there is excess lime in the surface layer. Because of the lime, not enough iron is available.

Capability unit IVE-3, dryland; IIe-3, irrigated; Sandy range site; Sandy woodland site.

Soil Formation and Classification

In this section are discussed the five major factors of soil formation and the classification of soil series by orders and great soil groups.

Factors of Soil Formation

Soil is produced by weathering and other factors of soil development acting on the parent materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the climate under which the soil material has accumulated and existed since it accumulated; (2) the plant and ani-

mal life in and on the soil; (3) the physical and mineralogical composition of the parent material; (4) the relief, or topography; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil formation. They act on the parent material accumulated through the weathering of rocks and slowly change it into a natural body having genetically related horizons. The effects of climate and vegetation are conditioned by relief. The kind of parent material also affects the kind of profile that can be formed and, in extreme cases, dominates it entirely. Finally, time is needed to change the parent material into a soil. The time needed for horizon differentiation may be much or little. Normally, a long interval of time is needed for the development of distinct horizons.

Although the individual factors of soil formation are discussed separately in this report, it is the interaction of all of these factors that determines the characteristics of the soil.

Climate

Climate is an active factor in the formation of soils. It influences their formation both directly and indirectly. Climate affects the weathering and reworking of parent material directly through rainfall, temperature, and wind. It affects the soils indirectly through the amount and kind of vegetation and animal life sustained.

Within an area as small as Dundy County, the climate is fairly uniform and differences in the soils cannot be attributed to differences in climate. Climate causes differences, however, in the soils over broad areas. For example, well-drained soils in areas where the climate is more humid are more acid than well-drained soils in this county, even though they formed in similar parent material and have similar relief. They are also weathered to a greater depth.

The climate under which the soils of this county formed is semiarid, cool, and temperate. There are extremes in temperature and variations in the amount of rainfall. The average annual precipitation is about 17 inches. Most of the precipitation falls during the summer as sudden, intense thunderstorms. Temperatures are high for 3 months during the summer and low during the winter. The average annual temperature is about 53° F. The ground is frozen for about 3 months of the year.

The humidity is somewhat low. Wind velocities are high late in fall and during the winter and spring. Extended periods of drought occur. Droughts have several effects on the soils. The lack of moisture reduces chemical weathering and leaching; it reduces or stops the growth of plants; and it permits fine particles of minerals and organic matter to be lost from cultivated soils that are not protected during periods of blowing. Thus, the combined effects of dry weather and blowing over a long period of time can change greatly the physical and chemical properties of the soils.

The direct weathering of the soft parent material is more active in summer than at any other time. Even in summer, however, moisture may be lacking and weathering reduced. The lack of moisture is the result of insufficient precipitation, a high rate of evaporation, and loss

of moisture through runoff. The total amount of precipitation in the county is not great enough to leach the soils to any great extent. The free calcium in the soils tends to keep the colloidal clay granulated, and there is little downward movement of clay in the soil profile. Alternate freezing and thawing tend to flocculate the soils into soil aggregates, but this is often offset by lack of moisture and high winds in winter.

Plant and animal life

In this county the rather limited supply of moisture supports only a moderate growth of grasses. As a result, the color of the soils is affected, and also their content of organic matter and physical and chemical properties. The fibrous root system of the grasses tends to keep the soils granular. In addition, the grasses extract calcium and other minerals from the lower part of the soil and return them to the surface through their stems and leaves. This process of redistribution tends to keep the normal soils neutral in reaction.

Many kinds of micro-organisms are needed to transform organic remains into stable humus from which plants can obtain nutrients. Earthworms and small, burrowing animals influence the formation of soils by mixing the organic and mineral parts of the soils and by deepening the zone in which the organic matter accumulates. They also tend to keep the soils supplied with minerals by bringing unleached parent material to the surface.

Because the climate of this county somewhat limits the growth of vegetation and the amount of leaching and weathering, other soil-forming factors become important. These are *parent material*, *relief*, and *time*. The soils vary because there are extreme variations in parent material, relief, and time.

Parent material

During the last main geologic period, which dates back about a million years, climate had much to do with shaping the land surface and with making and depositing the parent material of the soils in Dundy County. During that period, most of the county was capped with soft parent material. Winds blew particles of sand, silt, and clay from weathered rock into mounds of various shapes and thicknesses. The mounds formed by sand made up the billowy topography of the sandhills. The silt blown from river valleys caught and lay in such areas as the broad loessal plain in the northeastern part of what is now Dundy County. Then, the windblown material became eroded, and a drainage system was established. Gradually, plants began to grow and soils started to form.

Parent material is still being deposited. Most of the soils that are cultivated and not protected against blowing are losing fine material from the surface layer. In contrast, the soils on sandhills in native pasture are accumulating fine particles of dust. As a result, they have a surface crust that is finer textured than the material in the surface layer. This crust is ¼ inch to 1½ inches thick.

The soils in the county have developed from a number of kinds of parent material. These are (1) windblown silt (Peorian loess); (2) windblown silt and residuum

from Cretaceous shale; (3) mixed windblown silt, sand, and residual material from Tertiary rocks; (4) windblown sand; (5) residuum weathered from Tertiary rocks; (6) colluvium; and (7) alluvium. Of these, the soils formed in windblown silt, windblown sand, and alluvium are the most extensive. All of these materials were deposited in late geologic time, during the Pleistocene epoch.

Windblown silt (Peorian loess).—Silt laid down by wind forms a mantle over the eastern part of the county and covers the areas south of the Republican River. A number of fertile soils, mainly the Colby, Goshen, Keith, Scott, and Ulysses silt loams, have formed in it. The loess consists of uniform, fine-grained, calcareous sediments and contains many small rootlets and vertical root holes that are lined or filled with calcium carbonate.

The loess is gray, yellow, or brown. In exposed banks weathering has caused it to form vertical columns. The loess is believed to have originated in regions to the north and west.

Windblown silt and residuum from Cretaceous (Pierre) shale.—In the uplands along the lower slopes of the valley of the Republican River are gently sloping to sloping soils formed in mixed parent material. Their parent material consisted of windblown silt and material weathered from clay shale of Cretaceous age. These soils are deep to moderately deep over the weathered shale. They have a moderately fine textured subsoil.

The shale was laid down when a vast sea covered the area that is now Dundy County. Before it became weathered, this shale was dark gray to black and was platy. In many places the shale contains thin lenses and seams of gypsum that weather out near the surface as aggregates of crystals.

This shale underlies the entire county. It is exposed in several places, especially in the southwestern part of the county and in the lower valley slopes along streams. As parent material, the shale is generally mixed or capped with Peorian loess. It does not form an extensive part of the parent material of any of the soils. Nevertheless, it is important because it increases the content of salt in the ground water and furnishes salts that affect the soils on bottom lands. The soils formed in this kind of parent material are Ulysses loam, clay substratum variant, and Ulysses clay loam, clay substratum variant.

Mixed windblown silt, sand, and residual material from weathered Tertiary rocks.—Several extensive soils in the county, mainly the Anselmo, Goshen, Keith, and Ovina soils, formed in this kind of parent material. This material in most places is deep and silty, but in some places it is sandy. It has been blown in from areas of surrounding soils.

Windblown sands.—Windblown sand forms a mantle over most of the western part of the county north of the Republican River. The sand is well sorted and consists of clean grains that are rounded and scratched to give them a frosted appearance. Most of the sand is quartz, but part of it was derived from feldspar. It is loose and porous, and sloughs from the sides of exposed banks.

The sand was blown by the wind into hummocks or hills, which form the typical relief of the sandhills. The sand is believed to have originated mainly in regions to the northwest or to have weathered from sandstone

of Tertiary age. Soils developed slowly from this kind of parent material, and most of the soils formed in it are low in fertility. The soils formed in this kind of parent material are the Dunday, Elsmere, Gannett, and Valentine.

Residuum weathered from Tertiary rocks.—Residuum from Tertiary rocks that are only slightly weathered is a minor source of parent material in the county. Residuum from the Ogallala formation is the main source of this material. The Ogallala formation underlies Peorian loess or windblown sand in a large part of the uplands and is exposed in several places on the sides of valleys along streams.

This formation is made up of limestone, siltstone, or sandstone that alternates with unconsolidated beds of sand, gravel, silt, and clay. In some places the beds are cemented with lime and are called magnesia rock or caliche. Soils formed in material weathered from the rocks of this formation vary to the extent that the rocks have been exposed to weathering and the material weathered from them has been reworked. The soils formed in this kind of parent material are the Canyon and Vebar.

Colluvium.—Colluvium consists of mixed deposits of soil material and fragments of rock near the base of slopes. In this county it is made up mainly of recent, deep deposits of loamy material near the base of slopes in the uplands. The deposits have accumulated through soil creep, slides, and local wash. Colluvium is not a major source of parent material in this county, but it is the parent material of the Bayard and Bridgeport soils.

Alluvium.—Alluvium is a heterogeneous mixture of silt, clay, sand, gravel, and soil material washed from higher areas and deposited by rivers and streams. In this county it is mainly on flood plains and bottom lands along the Republican River and its tributaries. In many places that are already covered by alluvium, fresh deposits are added from time to time. In Dundy County most of the soils formed in alluvium are young and have not developed clearly expressed horizons. They vary because of differences in the source of parent material. The soils formed in alluvium in this county are the Banks, Glendive, Havre, Las, Las Animas, Laurel, Platte, and Rauville.

Relief

Relief influences soil development through its effect on drainage and runoff. Soils on strong slopes absorb less moisture and normally have less well-developed profiles than soils on flats or in depressions. Also, on steep slopes, the soil-forming processes tend to be retarded because of continuous erosion.

Time

Some soils that have been in place for only a short time have not been influenced enough by climate and vegetation to have developed well-defined, genetically related horizons in their profile. Most soils of the first bottoms are of this kind. Soils on steep slopes have their materials constantly removed by geologic erosion and do not develop genetically related horizons. These two broad groups, the soils on the first bottoms and on the slopes, are the young soils of the county.

Some soils in Dundy County have been in place for a long period and are approaching equilibrium with their environment. These soils have been in place long enough to develop genetic profiles and horizons with some thickness.

Classification of Soils

In table 11 the 23 soil series of Dundy County are placed in soil orders and great soil groups. In addition, some of the factors that have contributed to the morphology of the soils are listed.

Soil orders

Soils are classified in three orders—zonal, azonal, and intrazonal. Zonal soils have formed where the parent materials have been in place for a long time and have not been subject to extreme conditions of relief or to extreme durability of the parent materials themselves. Zonal soils have well-developed soil characteristics that reflect the influence of the active factors of soil genesis—climate and living organisms.

The well-drained, well-developed soils in this county have formed under relatively similar conditions of climate and vegetation and are zonal soils. On these soils climate and vegetation have had the most influence, and relief and age have had the least. As a result, these soils

have many properties in common, although they may have developed from various kinds of parent material.

In areas of the county where the parent materials have been in place for only a short time, the soils with only poorly defined or no genetic horizons have formed. Soils that are forming on recently transported materials are of this kind. These soils are young and have few or none of the properties of zonal soils and are called azonal soils. Because of their youth, their parent material, or their relief, a profile with well-developed soil characteristics has not developed in azonal soils.

Some azonal soils are characterized by an A₁ horizon that is moderately dark colored and apparently moderately high in organic matter; by the absence of a zone of illuviation, or B horizon; and by parent material that is normally lighter colored than the A₁ horizon. Because of the absence of a B horizon, these soils are called AC soils.

Other azonal soils on steep slopes are essentially AC soils because their materials are constantly renewed or are mixed and the changes brought about by climate and vegetation are slight. Here, only a small amount of water percolates through the soil, and much rapid runoff causes rapid geologic erosion.

On some nearly level areas in the county where both internal and external drainage are restricted or where geo-

TABLE 11.—*Soil series arranged by orders and great soil groups, and selected characteristics of the soil series*

ZONAL SOILS					
Great soil group and series	Physiographic position	Relief	Water relation	Parent material	Native vegetation
Chestnut soils:					
Anselmo.....	Uplands.....	Nearly level to rolling..	Well drained.....	Wind-worked sand and silt.	Mid grasses.
Goshen.....	Swales in uplands.....	Level to gently sloping..	Receives runoff....	Loess reworked by water.	Mid grasses.
Keith.....	Uplands.....	Nearly level to sloping..	Well drained.....	Loess.....	Mid and short grasses.
Ulysses.....	Valley slopes.....	Nearly level to sloping..	Well drained.....	Loess or a mixture of loess and shale.	Mid and short grasses.
Vebar.....	Uplands.....	Nearly level to sloping..	Well drained.....	Weathered, sandy caliche.	Mid and short grasses.
Chernozems intergrading to Alluvial soils:					
Ovina.....	Valleys in sandhills....	Level to gently sloping..	Seepage	Wind-worked sand..	Mid and tall grasses.
INTRAZONAL SOILS					
Humic Gley soils:					
Gannett.....	Upland depressions in sandhills.	Level to gently sloping..	High water table..	Sandy material reworked by wind.	Tall grasses and sedges.
Rauville.....	Flood plains.....	Nearly level.....	High water table..	Recent alluvium, dominantly silty.	Tall grasses and sedges.
Planosols:					
Scott.....	Upland depressions ..	Nearly level.....	Frequently flooded and ponded.	Loess.....	Short and mid grasses.
Solonechak soils:					
Laurel.....	High bottoms.....	Nearly level.....	Seepage.....	Silty alluvium.....	Salt and alkali grasses.

TABLE 11.—*Soil series arranged by orders and great soil groups, and selected characteristics of the soil series—Continued*

AZONAL SOILS

Great soil group and series	Physiographic position	Relief	Water relation	Parent material	Native vegetation
Alluvial soils:					
Banks.....	Flood plains.....	Level to undulating.....	Well drained.....	Sandy alluvium.....	Mid grasses.
Bayard.....	Colluvial slopes and fans.....	Nearly level to sloping.....	Well drained.....	Sandy colluvium and alluvium.....	Mid grasses.
Glendive.....	High bottoms.....	Nearly level.....	Well drained.....	Sandy alluvium.....	Mid and short grasses.
Havre.....	High bottoms.....	Nearly level.....	Well drained.....	Silty alluvium.....	Mid and short grasses.
Las.....	Flood plains.....	Nearly level.....	Moderately high water table.	Sandy alluvium.....	Mid and tall grasses.
Las Animas.....	Flood plains.....	Level to undulating.....	Moderately high water table.	Sandy alluvium.....	Mid and tall grasses.
Platte.....	Flood plains.....	Nearly level.....	High water table.	Thin layer of silty alluvium over gravel.	Mid and tall grasses.
Alluvial soils intergrading to Chestnut soils:					
Bridgeport.....	Colluvial slopes and fans.....	Nearly level to sloping.....	Well drained.....	Silty colluvium and alluvium.	Mid and short grasses.
Alluvial soils intergrading to Chernozems:					
Elsmere.....	Valleys in sandhills.....	Level to gently sloping.....	Seepage.....	Wind-worked sand.	Mid and tall grasses.
Lithosols:					
Canyon.....	Uplands.....	Gently sloping to rolling.	Well drained.....	Caliche.....	Short grasses.
Regosols:					
Colby.....	Uplands.....	Rolling to broken slopes.	Excessively drained.	Loess.....	Short and mid grasses.
Valentine.....	Sandhills.....	Rolling to hilly.....	Well drained to excessively drained.	Sand.....	Mid and tall grasses.
Regosols intergrading to Chestnut soils:					
Dunday.....	Valleys in sandhills.....	Nearly level to gently sloping.	Well drained.....	Sandy material reworked by wind.	Mid grasses.

logic erosion is very slow, the soils have developed from materials that have been in place a long time. These soils have certain well-developed profile characteristics that zonal soils do not have. They are associated geographically with the zonal soils and are called intrazonal soils. Intrazonal soils are defined as soils with more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief or parent material over the normal effects of climate and vegetation. The properties of intrazonal soils in this area are generally the result of level relief.

Soils of each of the three orders—zonal, azonal, and intrazonal—may be derived from similar kinds of parent materials. In this area, the major differences of the soils in any one of these orders appears to be closely related to differences in the kinds of parent materials. The thickness of soil over the rock from which it was derived is partly determined by the resistance of the rock to weathering, the volume of residue after weathering, and the rate of geologic erosion. Some areas may have been influenced by the addition of loess or eolian sands.

Great soil groups

A great soil group consists of many soil series that have soils with major characteristics in common. Every soil series in a great soil group has soils with the same number and kinds of definitive horizons, although these horizons may not be expressed to the same degree in every profile. Collectively, the members of a single great soil group have a wide range in many characteristics or properties. They also have a wide range in fertility, tilth, moisture-holding capacity, susceptibility to erosion, and other qualities.

The great soil groups in Dundy County are the Chestnut soils, Humic Gley soils, Planosols, Solonchak soils, Alluvial soils, Lithosols, and Regosols. In addition there are Chernozems intergrading to Alluvial soils, Alluvial soils intergrading to Chestnut soils, Alluvial soils intergrading to Chernozems, and Regosols intergrading to Chestnut soils.

CHESTNUT SOILS

The Chestnut great soil group consists of zonal soils that have a dark grayish-brown or brown A horizon and a somewhat lighter brown B horizon. These, in turn,

overlie a horizon of lime accumulation that is commonly at a depth of 1 to 4 feet. The Chestnut soils developed under mixed short, mid, and tall grasses in a temperate to cool, subhumid to semiarid climate. In Dundy County the Keith, Anselmo, Goshen, Ulysses, and Vebar soils are in this great soil group.

Keith soils.—The Keith soils are typical of the Chestnut great soil group. They are well drained, nearly level to gently sloping, and have formed in medium-textured, windblown material. The native vegetation is mid and short grasses. These soils have a profile of moderate thickness; the profile is about 2 feet thick. The A horizon is grayish and brownish in color, and the B horizon is brownish. The B horizon has weak to moderate structure, but it contains little or no more clay than the A horizon.

Free lime has leached from the A and B horizons but has accumulated at $1\frac{1}{2}$ to 3 feet below the surface. The pH of the surface layer and upper part of the subsoil is about 7.0 (neutral), but it increases to 8.0 or 8.5 in the lower lime zone and in the calcareous parent material.

The typical Keith silt loams are on narrow ridges that run northwest-southeast on the loessal plain in the uplands in the eastern part of Dundy County. They are associated with the Keith silt loams, thick, of the broad upland flats. It is believed that the old loessal plain has been altered where the Keith soils, thick, formed, but that the typical Keith silt loams are in areas that have not been affected materially by deposition or erosion. Thus, weathering and development in Keith silt loams have been in progress for a long period of time. In a few places the B horizon has stronger structure and contains more clay than is typical. The layers in the B horizon, however, are thin, and in a few places the calcareous parent loess is exposed at the surface.

In the Keith silt loams, thick, there is a dark-colored layer that was the surface of an old soil now buried. This layer shows few signs of former subsoil development. This indicates that a thin layer of loess was deposited over the old soil and covered the former surface layer. The deposit of loess gradually darkened and made a younger, thicker, and darker profile than that of the original soil. In places the present subsoil has developed in the dark, buried soil.

The Keith fine sandy loams and the Keith fine sandy loams, thick, are in lower positions than the Keith silt loams and the Keith silt loams, thick. They developed mostly in thin deposits of loess, but in a few places they formed, at least partly, in material weathered from Tertiary rocks. The Keith, caliche substrata, soils developed in weathered or reworked residuum derived from Tertiary material.

Anselmo soils.—The Anselmo soils are also in the Chestnut great soil group. They are thought to have developed in a way similar to that in which the Keith soils, thick, developed. The Anselmo soils have a multistory profile in which the texture is sandy loam. Much of the acreage is in upland valleys, which possibly held lakes at one time. Thin, windblown and waterborne sediments gradually filled in these low areas. The sediments came from areas where the soil materials were more sandy, less calcareous, and contained less organic matter than the thin, silty, loessal sediments that were

the principal parent material of the Keith soils, thick. The native vegetation was mid grasses.

The Anselmo soils have no doubt been influenced in places by soft, calcareous material that resembles marl. It is possible that in some areas they developed in place on weathered Tertiary material. In most places, however, these soils probably were developed in material, reworked locally, that was derived from Tertiary sources.

The content of clay in the parent material of these soils is as high as or higher than the content of silt. This indicates that the sediments from which the parent material was derived contained a high proportion of fine particles.

Goshen soils.—The Goshen soils are moderately well drained or well drained. They formed in sandy and silty materials washed from the soils of surrounding areas. The native vegetation was mid grasses. These soils have a thick, dark grayish-brown A horizon. Their B horizon is moderately thick and is dark grayish brown. The B horizon is underlain by a lighter grayish-brown, massive C horizon. Typically, there is no free lime in the profile above a depth of 30 inches.

Ulysses soils.—The Ulysses soils have a moderately dark, granular, silty A horizon and a moderately light colored, weakly prismatic, calcareous B horizon. The C horizon is light-gray, silty loess that is high in lime. The Ulysses soils formed under mid and short grasses. They are on high foot slopes, in a position where Bridgeport soils normally occur. The Bridgeport, however, have little or no profile development.

Vebar soils.—These soils, although classified as Chestnut soils in Dundy County, are not entirely typical of the soils of that great soil group. Vebar soils normally have a weak B horizon, but in Dundy County they have a dark grayish-brown A horizon over a light brownish-gray AC horizon. The D horizon of slightly weathered limestone or sandstone is 16 to 36 inches below the surface. Free lime extends to the surface in some places, but in others it is as deep as 16 inches. The native vegetation was mid and short grasses.

CHERNOZEMS

Chernozems are zonal soils that have a thick, dark, granular A horizon that is rich in organic matter. The B horizon, commonly lighter colored than the A, has subangular blocky or prismatic structure. In most profiles there is an accumulation of calcium carbonate in the lower part of the B horizon. The calcium carbonate is at a depth of $1\frac{1}{2}$ to 4 feet. No true Chernozems occur in Dundy County, but the Ovina soils are classified as Chernozems intergrading to Alluvial soils.

Ovina soils.—The Ovina soils have some of the characteristics of Chernozems, but they are intergrading to Alluvial soils. They have a very weak B horizon that is typical of the Chernozems. The Ovina soils have a thick, gray surface layer and a light-gray C horizon. Their substratum is silty, and their entire profile contains an abundance of disseminated lime. The soils formed under mid and tall grasses.

HUMIC GLEY SOILS

This great soil group is made up of poorly drained or very poorly drained intrazonal soils that have a thick,

black A horizon, high in content of organic matter. They have a gray or mottled B or C horizon. The soils have formed in areas that are poorly drained, under a rank growth of grasses. The Gannett and Rauville soils are classed as Humic Gley soils. The soils of both series formed under tall grasses and sedges.

Gannett and Rauville soils.—The Gannett soils are wet, moderately sandy soils of uplands. They have a black A horizon, a dark-gray AC horizon, and a gray, gleyed C horizon. The profile contains free lime in the upper part, but none of the lime is visible in the lower part.

The Rauville soils are much like the Gannett soils, except that their upper layers are silty instead of sandy. Also, the Rauville soils formed on flood plains instead of uplands.

PLANOSOLS

Planosols are intrazonal soils that have leached surface and subsurface horizons that are underlain by a compact, claypan subsoil. Only the Scott series is classified in this great soil group in Dundy County.

Scott soils.—The soils of the Scott series formed in basinlike depressions in the uplands. Their A horizon is black, granular silt loam that is about 6 inches thick. It overlies a thick B horizon of silty clay. The C horizon is lighter colored and coarser textured than the B horizon. The Scott soils contain no free lime. They formed under short and mid grasses.

OLONCHAK SOILS

This great soil group consists of intrazonal soils that have a high concentration of soluble salts. The soils do not have clearly differentiated horizons. They have formed under a cover of grasses and shrubs that tolerate salt, in a cool to tropical, arid to subhumid climate. In many places they receive seepage or runoff water from adjacent areas. The soils of the Laurel series are the only Solonchak soils mapped in Dundy County.

Laurel soils.—The Laurel soils are very strong alkaline or saline soils that formed in deep, silty or slightly sandy sediments on the flood plains of the Republican River. These soils are nearly level. They have a water table that is 2 to 8 feet below the ground surface.

The surface layer is a moderately dark, granular loam. The underlying material is grayish brown and silty. It is very strongly alkaline and contains soluble salts in considerable amounts. Lime is present in the entire profile.

ALLUVIAL SOILS

The Alluvial great soil group consists of azonal soils formed in alluvium that has been deposited recently. Except for additions of organic matter, which have darkened the soil material in the surface layer, the alluvium deposited has had little or no modification by soil-forming processes. In Dundy County the Banks, Bayard, Glendive, Havre, Las, Las Animas, and Platte series are in this great soil group.

The Elsmere soils are classified as Alluvial soils, but they have some characteristics of Chernozems. The Bridgeport soils are also classified as Alluvial soils, though they have some characteristics of Chestnut soils.

Banks soils.—The Banks soils have a thin, light-colored, very sandy A horizon that is single grained or has only a very weak, granular structure. The C horizon

is pale-brown fine sand. The A horizon is not calcareous in all areas, but the underlying material is. The Banks soils formed under a cover of mid grasses.

Bayard soils.—These are moderately sandy soils that formed in deposits near the base of upland slopes or in higher lying areas where sediments have been deposited by wind or water. The soils have a light colored to moderately dark colored A horizon and lighter colored underlying material. Lime is present throughout the profile.

Glendive and Havre soils.—The Glendive soils have a dark, granular A horizon over a brownish C horizon that has prismatic structure. Lime is present throughout the profile, which in most places has a texture of fine sandy loam. These soils have formed under native vegetation that consisted of mixed grasses, mainly mid grasses, such as western wheatgrass, little bluestem, and side-oats grama.

The Havre soils are similar to the Glendive soils, but they have a surface layer that is more loamy. In addition, their C horizon is silty or consists of stratified silt and very fine sand. The native vegetation was originally short and mid grasses, such as western wheatgrass, side-oats grama, and blue grama.

Las soils.—The Las soils have a light colored to moderately dark colored, loamy A horizon that overlies a coarser textured C horizon. They have a water table 2 to 6 feet below the surface. The A horizon is limy. In places it is mildly to strongly alkaline and slightly to strongly saline. In places the C horizon is also alkaline or saline. These soils formed under a cover of mid and tall grasses.

Las Animas soils.—These soils have a dark-colored, sandy A horizon that shows little structural development. In places they contain a large amount of lime and a moderate amount of alkali salts. The C horizon consists of stratified, sandy sediments that are lighter colored than the A horizon. These soils formed under a cover of tall grasses.

Platte soils.—The Platte soils have a moderately dark, loamy A horizon that is high in lime. The underlying C horizon consists of dark-brown, coarse sand or mixed sand and gravel. The D horizon is coarse sand and gravel that lies 6 inches to 2 feet below the surface. Because the water table is moderately high to high, these soils formed under native vegetation of coarse prairie grasses, scattered willow saplings, and other trees and shrubs.

Bridgeport soils.—The Bridgeport soils have some properties of Alluvial soils and some of Chestnut soils. Therefore, they are classified as Alluvial soils intergrading to Chestnut soils. The Bridgeport soils formed chiefly in light-colored materials that have slipped or washed from higher lying soils along local drainageways, on fans, or on foot slopes. Where the soils extend along the upper parts of drainageways, the parent material includes sediments from the Tertiary and Cretaceous ages.

The Bridgeport soils have been in place for only a short time and have thin to moderately thick upper layers darkened by organic matter. Calcium carbonate has not been leached from the surface layer.

Elsmere soils.—The Elsmere soils, classified as Alluvial soils, have some characteristics of Chernozems and are intergrading to that great soil group. They have a thick, very dark gray, sandy A horizon and a gray or

grayish-brown C horizon. Their entire profile contains an abundance of disseminated lime, and concretions are present in the upper part of the C horizon. The Elsmere soils are sandy throughout.

LITHOSOLS

Lithosols are azonal soils that are freshly and incompletely weathered. They do not have clearly expressed horizons. Most Lithosols formed on steep slopes. In some places, however, they are in areas where the slopes are less steep. In those areas the rock is resistant to weathering or the parent material is too new to have permitted development of a mature soil. In Dundy County the Canyon soils are classified as Lithosols.

Canyon soils.—These soils have a dark grayish-brown or grayish-brown A horizon that overlies slightly weathered limestone or sandstone. The soil material above bedrock ranges from 6 to 18 inches in thickness. The native vegetation was mainly short grasses.

REGOSOLS

This great soil group consists of soils in which few or no clearly expressed soil characteristics have developed. The soils are on the steep slopes of loessal canyons and hills. Their profile is thin and shows little alteration from the underlying deep, loessal deposits of light-colored, soft, limy parent material. They have a thin surface layer that is slightly darkened by organic matter. Free lime has not leached from the surface layer. Normal runoff is rapid because of the steep slopes.

Colby and Valentine soils.—The Colby soils have developed in deep, silty loess or in parent material that resembles loess. They have an A horizon of grayish-brown loam that is 3 to 10 inches thick. The A horizon overlies the C horizon of light-gray silt loam. The Colby soils have lime at the surface and throughout the profile. They formed under a cover of short and mid grasses.

The Valentine soils formed in windblown sand consisting of particles of uniform size. They have a slightly darkened, sandy A horizon that is 6 to 10 inches thick. The underlying material (C horizon) is grayish, brownish, or yellowish-brown, loose sand. These soils contain no free lime. The native vegetation was mid and tall grasses.

Although the Colby and Valentine soils are similar in the kinds and numbers of horizons, they differ in some important respects. Little of the rain that falls on the Colby soils is absorbed in the profile. This is because of the silty texture of the surface layer and, in many places, the steep slopes, which cause a large amount of runoff and the resultant normal erosion.

The Colby soils are rich in weatherable minerals, but the scarcity of moisture and the rapid natural erosion keep profile development to a minimum. In comparison, the Valentine soils are very sandy. Most of the rain that falls on them is absorbed, penetrates deep into the soil, and leaches out the free lime. The low content of weatherable minerals, however, also keeps soil development to a minimum in the Valentine soils.

Dunday soils.—The Dunday soils have some characteristics of Regosols. They also have some characteristics of Chestnut soils and are, therefore, classified as Regosols intergrading to Chestnut soils.

The Dunday soils have a moderately dark, weakly granular A horizon that is 10 to 18 inches thick. The underlying C horizon is dark brown and shows some blocky structure. These soils contain no free lime.

The Dunday soils are nearly level and formed in fine sand or loamy fine sand. They contain enough fine material and support enough vegetation to produce a slightly thicker and darker A horizon than the Valentine soils. The Dunday soils have no developed B horizon. The water table is so deep that it has no effect on the vegetation or soil profile. These soils commonly have a multistory profile that contains a buried soil in which the A horizon has a texture of loamy sand.

Dunday loamy fine sand, loam substratum, is unique in that it has a layer that is partly cemented and about 8 inches thick in the lower part of the subsoil or substratum. The partly cemented horizon is not present in all areas. Where it is absent, the surface covering of windblown loamy fine sand or fine sand rests upon material that consists of mixed calcareous sand and silt.

The substratum of this soil, including the partly cemented layer, is thought to consist of Tertiary materials. Unsorted materials, scattered pebbles, stones, and sand that is coarser than that in the surface layer are in the loamy substratum.

When moist, the partly cemented layer loses some of its hardness. Drainage apparently is still affected, however, because there are, in some areas, bare scab spots on this soil where water stands after wet periods. In these places the partly cemented horizon is near the surface.

It is not known whether this horizon is the former surface layer of an old buried soil or is some other part of an old soil. In most areas the water table is 7 to 15 feet below the surface. It is possible that in some earlier period the water table influenced the development of the partly cemented layer, probably in a saline soil that later became a Solonetz soil. The partly cemented horizon could be the remains of a B horizon of an old Solonetz soil. It is possible that this horizon is the result of compaction of fine, medium, and coarse sands with small amounts of clay or that it is partially cemented with silica in combination with organic matter. The pH of the layer is not high, but it increases with depth, especially in areas where there is soft material that resembles marl.

Mechanical and Chemical Analyses of Soils

This section has two main parts. In the first the methods of analyses used in the field and laboratory are discussed and a table is given that shows the results obtained when the soil samples were analyzed. In the second, profiles are described for some of the soils analyzed.

Field and laboratory methods

Table 12 gives analytical data for selected soils. All of the samples used to obtain the data were collected from carefully selected pits. The samples are considered representative of the soil material that is made up of particles less than three-fourths of an inch in diameter. Estimates of the fraction of the sample consisting of particles larger than three-fourths of an inch in diameter were made when the soils were sampled.

TABLE 12.—*Analytical*
[Analyses made at Soil Survey]

Soil, location, and sample and laboratory numbers	Horizon depth	Particle-size distribution		
		Very coarse sand (2.0-1.0 mm.)	Coarse sand (1.0-0.5 mm.)	Medium sand (0.5-0.25 mm.)
Anselmo loamy fine sand, 0 to 3 percent slopes (Dundy County, Nebr.): <i>Location:</i> 0.25 mile W. and 285 feet S. of NE. corner sec. 17, T. 2 N., R. 40 W.; about 8 miles W. of Parks, on U.S. Hwy. 34 and 8½ miles north in a cultivated field. <i>Sample No.</i> S57-Neb-29-6-(1-7). <i>Laboratory Nos.</i> 6841, 6842, 6843.	<i>Inches</i> 0 to 7 20 to 28 41 to 60	<i>Percent</i> 1.0 .3 -----	<i>Percent</i> 10.3 3.4 1.0	<i>Percent</i> 15.4 8.1 4.4
Bridgeport loam, 1 to 3 percent slopes (Dundy County, Nebr.): <i>Location:</i> 0.25 mile N. and 0.1 mile E. of SW. corner sec. 36, T. 2 N., R. 37 W.; about 120 feet N. of U.S. Hwy. 34 and 540 feet E. of culvert; about 3 miles SW. of Max, on U.S. Hwy. 34 in a cultivated field. <i>Sample No.</i> S57-Neb-29-1-(1-7). <i>Laboratory Nos.</i> 6814-6820.	0 to 5 5 to 11 11 to 23 23 to 35 35 to 47 47 to 56 56 to 66	.1 .1 .1 ----- ----- ----- -----	*.2 *.1 *.1 ----- *.1 *.1 *.2	*.2 *.1 *.1 *.1 *.3 *.3 *.4
Keith silt loam, 1 to 3 percent slopes (Hitchcock County, Nebr.): <i>Location:</i> 225 feet E. and 150 feet N. of SW. corner sec. 3, T. 1 N., R. 33 W.; about 7 miles S. and 1 mile W. of Trenton, in a cultivated field. <i>Sample No.</i> S54-Neb-44-3-(1-7). <i>Laboratory Nos.</i> 2402-2408.	0 to 6 6 to 10 10 to 13 13 to 20 20 to 30 30 to 42 42 to 60	**.1 ----- ----- ----- ----- ----- -----	**.1 ----- .1 ----- .1 ----- .3	.2 **.1 .3 .1 .3 .1 .3
Keith silt loam, thick, 0 to 1 percent slopes (Hitchcock County, Nebr.): <i>Location:</i> 0.6 mile N. and 150 feet W. of SE. corner of sec. 28, T. 3 N., R. 35 W.; 3½ miles N. and 2 miles W. of Stratton, in a cultivated field. <i>Sample No.</i> S54-Neb-44-1-(1-8). <i>Laboratory Nos.</i> 2387-2394.	0 to 6 6 to 13 13 to 17 17 to 29 29 to 36 36 to 44 44 to 54 54 to 60	**.1 ----- ----- ----- ----- ----- -----	.1 **.1 ----- ----- ----- ----- -----	.2 .2 **.1 .2 .2 **.1 .2 .1
Valentine fine sand, rolling (Dundy County, Nebr.): <i>Location:</i> 0.1 mile N. and 350 feet W. of center of sec. 34, T. 4 N., R. 41 W.; about 17½ miles N. of Haigler, in a native pasture. <i>Sample No.</i> S59-Neb-29-2. <i>Laboratory No.</i> 11233.	0 to 4	1.9	10.4	26.0
Valentine loamy fine sand (Dundy County, Nebr.): <i>Location:</i> 0.3 mile E. and 450 feet S. of NW. corner of sec. 7, T. 2 N., R. 37 W.; 7¼ miles N. and ½ mile W. of Benkelman, in a native pasture. <i>Sample No.</i> S59-Neb-29-9. <i>Laboratory No.</i> 11234.	1 to 5	.1	2.8	14.7

*A few concretions of calcium carbonate and a few smooth, black concretions.

**Organic matter in sand fractions.

After the samples were collected, the particles larger than three-fourths of an inch in diameter were discarded. Then, the material made up of particles less than three-fourths of an inch was rolled or crushed and was sieved to remove the pebbles or fragments of rock larger than 2 millimeters in diameter. The fraction that consisted of particles between 2 millimeters and three-fourths of an inch in diameter was recorded on the data sheets but was not listed in table 12, as only the Anselmo soil contained a trace of material of that size. Consequently, the percentages given in the table were calculated from

the total weight of the particles in the sample that measured less than three-fourths of an inch in diameter.

Except for the material larger than 2 millimeters in diameter, a trace of which was noted for the Anselmo soil, all laboratory analyses were made on oven-dry material that passed the 2-millimeter sieve.

Standard methods of the Soil Survey Laboratory were used to obtain the data given in table 12.

Analysis of particle-size distribution was made by the pipette method after dispersion with sodium hexametaphosphate and mechanical shaking (7, 9, 11). The per-

data for selected soils

Laboratory, SCS, Lincoln, Nebr.]

Particle-size distribution—Continued				Chemical analyses										
Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Reaction (pH)		Organic carbon	Nitrogen	Electrical conductivity (EC×10 ³) millimhos per cm. at 25° C.	CaCO ₃ equivalent	Cation exchange capacity (NH ₄ Ac)	Extractable cations (meq./per 100 g.)			
				1:1	1:10						Ca	Mg	Na	K
Percent	Percent	Percent	Percent			Percent	Percent		Percent	Meq./100 g.				
45.7	17.7	4.6	5.3	7.6	-----	0.39	-----	-----	-----	-----	-----	-----	-----	-----
42.6	24.4	9.3	11.9	7.4	-----	.26	-----	-----	-----	-----	-----	-----	-----	-----
46.1	35.2	5.8	7.5	7.7	-----	.05	-----	-----	-----	-----	-----	-----	-----	-----
*1.8	*43.8	42.5	11.4	8.2	8.8	.64	0.066	0.8	3	14.4	-----	-----	-----	2.2
*1.3	*41.2	45.3	11.9	8.2	8.8	.37	.044	.5	3	14.8	-----	-----	-----	1.4
*1.6	*47.2	40.8	10.1	8.3	8.9	.14	.019	.5	5	12.8	-----	-----	-----	1.0
*.8	*35.1	54.8	9.2	8.2	8.8	.19	.025	.4	4	15.3	-----	-----	0.1	1.2
*2.5	*44.5	39.8	12.8	8.0	8.7	.50	.050	.4	2	15.0	-----	-----	.1	1.0
*2.6	*45.4	38.3	13.3	8.1	8.8	.41	.043	.5	3	14.2	-----	-----	.1	1.2
*3.1	*45.8	37.1	13.4	8.1	8.8	.32	.035	.4	3	13.7	-----	-----	.1	1.3
.9	24.3	53.9	20.5	6.8	7.8	1.21	.104	-----	-----	20.6	15.3	3.3	.2	2.0
.5	19.6	53.4	26.4	6.9	7.9	.82	.078	-----	-----	20.5	16.9	3.9	.2	1.6
.9	19.9	52.4	26.4	7.0	8.0	.69	.071	-----	-----	23.5	17.9	4.2	.1	1.4
.4	21.6	52.3	25.6	7.1	8.2	.57	.064	-----	-----	23.4	17.5	4.6	.1	1.4
1.3	21.5	52.1	24.7	7.9	9.0	.40	.052	-----	3	21.9	-----	-----	.1	1.9
.6	24.0	55.4	19.9	8.1	9.3	.29	-----	-----	8	20.6	-----	-----	.2	2.7
1.2	28.1	53.9	16.2	8.1	9.3	.15	-----	-----	6	19.4	-----	-----	.3	3.2
1.1	23.6	55.4	19.5	6.7	7.2	1.87	.182	-----	-----	21.3	15.0	3.1	.1	3.3
.9	22.5	50.0	26.3	6.4	7.1	1.08	.098	-----	-----	23.2	16.3	4.2	.1	2.0
.4	21.0	53.3	25.2	6.2	7.0	.64	.067	-----	-----	22.4	15.6	4.3	.2	1.2
.8	22.6	48.3	28.1	6.6	7.6	.62	.072	-----	-----	24.6	17.7	5.1	.2	1.7
.7	23.4	49.1	26.6	7.9	8.8	.60	.063	-----	2	23.4	-----	-----	.2	2.4
.6	22.1	50.6	26.6	8.0	9.0	.40	.046	-----	5	22.9	-----	-----	.2	2.9
.7	26.5	52.6	20.0	8.0	9.1	.28	.034	-----	3	21.6	-----	-----	.3	3.3
.5	33.8	51.0	14.6	8.2	9.2	.18	.024	-----	5	19.8	-----	-----	.5	3.2
48.6	6.1	4.5	2.5	6.7	-----	.32	-----	-----	-----	-----	-----	-----	-----	-----
40.7	28.8	5.2	7.8	6.6	-----	.60	-----	-----	-----	-----	-----	-----	-----	-----

centage of fine clay was determined by centrifuging and pipetting.

The pH was determined by the glass electrode, using a soil-water ratio of 1:1 and of 1:10.

The content of organic carbon was determined by using a modification of the Walkley-Black method (12).

The total nitrogen was determined by using a modification of the AOAC procedure (2).

The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide evolved from

soil samples treated with concentrated hydrochloric acid (13).

The cation exchange capacity was determined by direct distillation of absorbed ammonia after saturation with ammonium acetate (12).

The extractable calcium and magnesium were determined by extraction with neutral normal ammonium acetate (12). The calcium was separated as calcium oxalate, and the magnesium, as magnesium ammonium phosphate. Extractable sodium and potassium were deter-

mined on original extracts, using the Beckman DU flame spectrophotometer.

Soluble sodium and potassium were determined on the saturation extract, using a Beckman DU flame spectrophotometer. The saturation extract was obtained by the method of the U.S. Salinity Laboratory (13).

Profile descriptions of the soils analyzed

A profile of the Bridgeport loam named in table 12 is described in detail as typical of the Bridgeport series in the section "Descriptions of Soils."

Profiles of the Anselmo, Keith, and Valentine soils, at the sites shown in table 12, are described in the following pages.

Profile of Anselmo loamy fine sand, 0 to 3 percent slopes, located 0.25 mile west and 285 feet south of the NE. corner of sec. 17, T. 2 N., R. 40 W.; about 8 miles west of Parks, on U.S. Highway No. 34 and 8½ miles north in a cultivated field:

- A_p 0 to 7 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, very fine, granular structure; loose when dry, very friable when moist; this horizon has been winnowed and some of the original silt and clay has been carried away by the wind; abrupt, smooth boundary.
- A₁ 7 to 13 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, blocky structure; soft when dry, very friable when moist; gradual, smooth boundary.
- B₁ 13 to 20 inches, dark grayish-brown to dark-brown (10YR 4/2.5) fine sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, blocky structure; soft when dry, very friable when moist; gradual, smooth boundary.
- B₂₁ 20 to 28 inches, dark grayish-brown to grayish-brown (10YR 4.5/2) fine sandy loam, very dark grayish brown (10YR 3.5/2) when moist; weak, coarse, blocky structure; soft to slightly hard when dry, very friable when moist; this horizon may have been an old surface soil; gradual, smooth boundary.
- B₂₂ 28 to 34 inches, dark grayish-brown to grayish-brown (10YR 4.5/2) fine sandy loam, very dark grayish brown (10YR 3.5/2) when moist; weak, coarse, prismatic structure separating to weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; contains krotovinas of lighter colored material; gradual, smooth boundary.
- B₃ 34 to 41 inches, light brownish-gray to pale-brown (10YR 6/2.5) fine sandy loam, dark grayish brown to dark brown (10YR 4/2.5) when moist; weak, coarse, blocky structure; soft when dry, very friable when moist; contains krotovinas of lighter colored material; gradual, smooth boundary.
- C 41 to 60 inches, light-gray to very pale brown (10YR 7/2.5) loamy fine sand, grayish brown to brown (10YR 5/2.5) when moist; massive; loose when dry, very friable when moist; contains krotovinas of darker colored material.

Profile of Keith silt loam, 1 to 3 percent slopes, located in Hitchcock County, Nebr., 225 feet east and 150 feet north of SW. corner of sec. 3, T. 1 N., R. 33 W.; about 7 miles south and 1 mile west of Trenton, in a cultivated field:

- A_{1p} 0 to 6 inches, dark-gray (10YR 4/1.5) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, friable when moist; abrupt, smooth boundary.
- A₁₂ 6 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; few light-colored worm casts; smooth lower boundary.
- B₁ 10 to 13 inches, dark grayish-brown (10YR 4.5/2) silty clay loam, very dark grayish brown (10YR 3.5/2)

when moist; fine, subangular blocky structure, but some vertical cracks result in coarse, primary blocky breakage when this layer is carefully removed from place; hard when dry, friable when moist; much worm activity; clear, smooth boundary.

- B₂ 13 to 20 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic separating to moderate, medium and fine, blocky structure; hard when dry, friable when moist; much worm mixing of material from above horizons; clear, smooth boundary.
- B_{2ca} 20 to 30 inches, light grayish-brown (10YR 6/2.5) silt loam or silty clay loam, grayish brown (10YR 5/2.5) when moist; moderate, fine and medium, subangular blocky structure; slightly hard when dry, friable when moist; some dark worm casts from horizons above; calcareous, white lime spots throughout and some disseminated lime in lower part; clear, smooth boundary.
- C_{ca} 30 to 42 inches, light-gray (10YR 7.5/2) silt loam, pale brown (10YR 6/3) when moist; massive but crushes to subangular, blocklike, firm lumps and loose, soft material; friable when moist, slightly hard when dry; calcareous, both segregated and disseminated lime; clear, smooth boundary.
- C 42 to 60 inches, light-gray (10YR 7/2.5) silt loam, pale brown (10YR 5.5/3) when moist; massive; calcareous, including a few fine threads and spots of segregated lime carbonate.

Profile of Keith silt loam, thick, 0 to 1 percent slopes, located in Hitchcock County, Nebr., 0.6 mile north and 150 feet west of SE. corner of sec. 28, T. 3 N., R. 35 W.; 3½ miles north and 2 miles west of Stratton, in a cultivated field:

- A_{1p} 0 to 6 inches, dark grayish-brown (10YR 4.5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and very fine, granular structure; soft when dry, friable when moist; abrupt lower boundary.
- A₁₂ 6 to 13 inches, dark grayish-brown (10YR 4/1.5) silt loam, very dark brown (10YR 2.5/2) when moist; moderate, fine, granular structure; soft when dry, friable when moist; clear, smooth boundary.
- A₃ 13 to 17 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3.5/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist; clear, smooth boundary.
- B₂ 17 to 29 inches, dark grayish-brown (10YR 4.5/2) silt loam or silty clay loam, very dark grayish brown (10YR 3.5/2) when moist; strong, medium and fine, subangular blocky structure; hard when dry, friable when moist; abrupt boundary.
- A_{1bca} 29 to 36 inches, gray (10YR 5/1.5) silt loam, dark gray (10YR 4/1.5) when moist; medium and fine, subangular blocky structure; slightly hard when dry, very friable when moist; calcareous, much accumulated lime carbonate; clear, smooth boundary.
- B_{bca} 36 to 44 inches, light-gray (10YR 7/2) silt loam or silty clay loam, light brownish gray (10YR 6/2) when moist; strong, medium and fine, subangular blocky structure; slightly hard when dry, very friable when moist; calcareous, faces of aggregates coated and pores and small openings filled with white lime carbonate; clear, smooth boundary.
- C_{bca} 44 to 54 inches, light-gray (10YR 7/2) silt loam, pale brown (10YR 6/3) when moist; massive, tending to break to very weak, subangular blocks; slightly hard when dry, friable when moist; few root channels and pores; calcareous, including spots, seams, and threads of white lime carbonate; gradual, smooth boundary.
- C_b 54 to 60 inches, light-gray (10YR 7/2.5) silt loam, pale brown (10YR 6/3) when moist; massive; soft when dry, very friable when moist; calcareous, few fine threads of white lime.

Profile of Valentine fine sand, rolling, located 0.1 mile north and 350 feet west of center of sec. 34, T. 4 N., R.

41 W.; about 17½ miles north of Haigler, in a native pasture:

- A₁ 0 to 4 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 3.5/2) when moist; weak, fine, granular structure; loose when dry or moist; clear, smooth boundary.
- A₁₂ 4 to 8 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2.5) when moist; single grain; loose when dry or moist; gradual, smooth boundary.
- AC 8 to 18 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 4.5/3) when moist; single grain; loose when dry or moist; gradual, smooth boundary.
- C 18 to 42 inches, very pale brown (10YR 7/3) sand, light yellowish brown (10YR 6/4) when moist; single grain; loose when dry or moist.

Valentine loamy fine sand, located 0.3 mile east and 450 feet south of NW. corner of sec. 7, T. 2 N., R. 37 W.; 7½ miles north and ½ mile west of Benkelman, in a native pasture:

- A₁₁ 0 to 1 inch, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; clear, smooth boundary.
- A₁₂ 1 inch to 5 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; clear, smooth boundary.
- AC 5 to 11 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; single grain; loose when dry or moist; gradual, smooth boundary.
- C 11 to 42 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; single grain; loose when dry or moist.

General Nature of the County

Discussed in this section are the history and settlement of Dundy County, transportation and markets, cultural and recreational facilities, water supply, climate, and agriculture.

Settlement and population

Early white residents in the area now within Dundy County were trappers and hunters who provided furs and buffalo hides for markets farther east. Hunters were followed by cattlemen from Texas, who in the early seventies took over most of the valley along the Republican River and the adjoining upland. In the sixties this valley had been a rest stop on the trail drives from Texas to the railhead at Ogallala, Nebr.

Losses of cattle were heavy because of severe winters, but ranching was the main enterprise until 1882, when the Chicago and Missouri Railroad was built through the valley of the Republican River to Denver, Colo. The railroad ended the early ranching era. Many homesteaders from the East came into the area in 1882-84. First settled were the valleys along streams, where wood and water were available, and then the areas farther from streams, where water was obtained by digging deep wells. Wood was scarce, so houses were built of sod. At first, tables were rarities, and the kerosene lamp, a luxury.

The homesteaders had good years and prospered until the early nineties. Then came years of drought and grasshoppers. Many settlers were forced to leave. The Federal census of 1900 showed half the population of 1890.

After 1900, all the county except the sandhill section was gradually resettled. The sandhill section never regained its earlier population. Those who remained in the sandhills were able to expand the original holding of 160 acres allotted under the Homestead Act to 640 acres under the Kincaid Act of 1904.

Population of the county reached its peak in 1930, when there were 5,610 inhabitants. A combination of drought, grasshoppers, and depressed prices in the thirties brought a sharp decline in population. Further, in 1935, high floodwaters swept down the Republican River without advance warning and caused great loss of life and property.

Decline in population, unbroken since 1930, was accelerated by the dry years of 1952 through 1956. The rural population was 3,570 in 1960.

Transportation and markets

A main line of the Chicago, Burlington, and Quincy Railroad and hard-surfaced highway U.S. 34 follow the valley of the Republican River across the southern part of the county. State Highway 61 runs north and south through Benkelman. These are the main connections with outside points.

County roads are mainly of earth. Most of them follow section lines, but in rougher areas they conform to the topography. Good roads are scarce in the sandhills.

Beef cattle, the greatest source of income, are shipped to markets outside the county, mostly to Denver, Colo.; Omaha, Nebr.; or eastern feeders. Two livestock sale barns operate in Benkelman, where there is also a meat-processing plant and a poultry hatchery.

Grain elevators are located in communities along the railroad, and a feed and milling company is located in Benkelman. To a large extent, grain and livestock products from the northeastern part of the county are marketed in Wauneta, Nebr., in Chase County.

Sugar beets have to be shipped into Colorado. Cream, eggs, and poultry are marketed locally.

Cultural and recreational facilities

Four accredited high schools are located in the county, one each in Benkelman, Haigler, Parks, and Max. The public school system is well developed except in parts of the sandhills, where schools are scarce. In 1957 there were 30 school districts, although not all operated because there were not enough children of school age. Students from these districts were transferred to nearby districts. Several village districts operate school buses, and the trend toward consolidation of school districts probably will continue.

Each town has several churches, and there are five rural churches, mainly in the eastern part of the county. The dominant faiths are Roman Catholic and Protestant.

Benkelman, the county seat and largest town, has a library, motion picture theatre, swimming pool, and golf course.

Facilities for boating, water skiing, swimming, picnicking, and fishing and hunting are available at Enders Reservoir, 25 miles north in Chase County, and Swanson Lake, 25 miles east in Hitchcock County. The State Recreation Grounds on Rock Creek, about 4 miles north-west of Parks, in Dundy County, provide camping, pic-

nicking, and fishing. A sports club at Twin Lakes, about 6 miles northwest of Benkelman, offers fishing and hunting. Several other private fishing and hunting spots are located in the county. The county offers fall hunting of wild ducks and geese, and hunting for pheasants and quail. Deer can be hunted, and rabbits are plentiful.

Water supply

Well water of good quality can be obtained in most parts of the county, but a sufficient supply is difficult to get on the outer edge of the valley of the Republican River and on the steep valley slopes along the Republican River. The rock formation in these areas is the almost impervious Pierre shale, which contains only a small amount of water of poor quality.

On the uplands, well water is obtained from the beds of sand and gravel in the Ogallala formation. The supply of ground water is determined by the amount that moves down from the surface. In the sandhill part of the county, intake of water is ideal, and the sands serve as an underground reservoir. In the sandhills, wells are about 75 feet deep, and on the broad loessal divides, about 250 feet.

On the bottom lands, the source of well water is river sand and gravel laid down over the Ogallala formation and the Pierre shale. These river deposits are thickest near the middle of the valley of the Republican River. The wells on the bottom lands are 10 to 40 feet deep.

Many springs issue at the level where the overlying deposits of the Ogallala formation contact the Pierre shale. Most of these springs are on the northern slope in the valleys of the Republican River and along creeks in the sandhills north of the Republican River. These springs provide much water for domestic use and livestock.

The ground water in this county generally contains dissolved solids—sulfates, chlorides, calcium, and sodium and potassium salts. The fluorine content of the ground water is high enough to inhibit tooth decay in school children. This was revealed by a 1955-56 survey made by the Nebraska State Department of Health, Division of Dental Health.

Climate¹

Dundy County, in the southwestern corner of Nebraska, is near the center of a large land mass. The nearest large body of water, Enders Reservoir, to the north, is not large enough to have an appreciable effect on climate. Difference of elevations has relatively minor effect, since the total difference in the county is approximately 600 feet, or from 3,500 feet in the northwestern corner to a little less than 2,900 feet in the valley of the Republican River at the eastern border.

The Rocky Mountains stop most of the moisture from the Pacific Ocean. To the west and southwest this barrier is high and unbroken. To the west-northwest the mountains are lower and more broken and permit winds from the west to pass. In contrast, to the north, east, and south, there is no obstruction to flow of air. Temperature changes, therefore, are frequent and large, particularly in winter, when the region to the north is very cold.

Records from Benkelman are sufficient to show fairly accurately averages and extremes of temperature and precipitation. Records at this station date from 1896, but there are many breaks between 1905 and 1915. Three tables were prepared mainly from these records. Table 13 shows the 10 driest years of record; table 14, the ten wettest years of record at Benkelman and the wettest year at Haigler; and table 15, the average temperature, extremes of temperature, and average precipitation by month and the year.

Winter is the driest season of the year. As shown in table 15, precipitation is low in December, January, and February. In winter, winds blow from the west or north most of the time. The winds from the west bring air that has lost most of its moisture in crossing the Rocky Mountains. These westerly winds bring fine, dry weather—warm days and frosty nights. When winds move down from the north, they bring cold weather. Many of these northern air masses, however, move southward well to the east of this county. Consequently, during one of these

¹Prepared by RICHARD M. MEYERS, State climatologist for Nebraska, U.S. Weather Bureau.

TABLE 13.—Ten driest years, Benkelman, Nebr.

[Based on a 56-year record, through 1959; years are listed, left to right, in order of increasing total precipitation]

Month	1934	1910	1931	1899	1955	1943	1954	1907	1937	1940
	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
January.....	0	0.10	0	0.40	0.64	0	0.22	¹ 0.20	0.40	0.66
February.....	.97	.20	.66	.40	.48	.10	(²)	(²)	.25	.27
March.....	.35	.04	1.49	.87	.06	.20	.44	.30	.75	1.91
April.....	.30	.76	.62	.20	2.51	.64	.48	¹ 1.40	.28	.17
May.....	.85	2.44	.30	1.25	2.76	1.80	2.45	1.45	1.34	.97
June.....	2.17	1.85	2.42	.90	1.66	3.20	2.62	2.60	3.13	2.57
July.....	.31	.52	.40	2.42	.89	2.84	1.51	3.60	1.89	.97
August.....	1.35	2.80	1.41	2.73	.44	1.94	2.32	2.13	1.68	1.43
September.....	2.32	1.16	2.50	(²)	1.66	.11	.33	.69	.80	1.73
October.....	0	0	.33	(²)	.06	.54	1.90	(²)	1.40	.52
November.....	.65	.03	.22	1.75	.17	.39	.05	(²)	.15	.40
December.....	.22	.25	.10	.30	.38	.43	.14	.10	.40	.97
Total.....	9.49	10.15	10.45	11.22	11.71	12.19	12.46	12.47	12.47	12.57

¹ Interpolated.

² Trace.

TABLE 14. — *Ten wettest years, Benkelman, Nebr. and wettest year, Haigler, Nebr.*

[Based on a 56-year record; through 1959; years are listed left to right in approximate order of decreasing total precipitation]

Month	1901	1930	1928	1923	1951	1902	1957	1912	1927	1946	¹ 1915
	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
January.....	0.10	0.35	0.18	0.10	0.12	0.25	0.32	0.40	0.40	0.10	² 0.35
February.....	.40	.58	.38	.10	.38	.38	.11	.95	2.20	.07	² .70
March.....	4.25	.41	.67	.65	.05	1.00	1.42	1.30	2.03	2.93	² 1.60
April.....	3.05	2.24	.44	1.71	2.25	1.01	2.35	3.99	2.93	.10	5.48
May.....	1.25	4.85	7.09	7.30	5.07	7.77	5.11	(³)	.71	5.64	7.61
June.....	6.27	3.08	5.33	5.98	4.23	2.70	5.06	2.72	8.43	1.09	2.98
July.....	² 1.30	5.86	6.13	3.35	2.30	4.00	5.79	5.73	.50	4.08	2.72
August.....	4.95	3.25	2.51	1.92	2.96	1.93	1.52	4.90	2.30	1.61	4.02
September.....	8.70	2.53	1.50	.56	7.61	3.70	1.43	2.45	2.95	.92	² 1.40
October.....	.45	3.42	3.05	4.39	1.22	² 1.85	1.35	1.36	.19	4.15	2.50
November.....	.15	2.23	.84	.06	.30	0	.71	.40	.23	2.47	² .35
December.....	.80	.18	(³)	.72	.26	1.50	.27	.80	.63	(³)	² .50
Total.....	31.67	28.98	28.12	26.84	26.75	26.09	25.44	25.00	23.50	23.16	30.21

¹ Data in this column from weather station at Haigler, Nebr. Records for Benkelman were incomplete.² Estimated.³ Trace.TABLE 15.—*Temperature and precipitation, Benkelman, Nebr.*

Month	Average temperature ¹	Highest temperature ²	Lowest temperature ²	Average precipitation ¹	Greatest 24-hour precipitation ³	Average snowfall ⁴	Chance of month having less than half of average precipitation ⁵
	<i>°F.</i>	<i>°F.</i>	<i>°F.</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Percent</i>
January.....	29.5	78	−27	0.40	1.05	3.1	36
February.....	33.7	80	−29	.35	.90	4.5	24
March.....	40.4	92	−19	.98	2.10	7.1	39
April.....	52.0	98	0	1.77	3.50	1.7	32
May.....	61.5	103	26	2.72	4.65	.4	21
June.....	71.8	111	35	2.59	2.68	0	20
July.....	78.9	114	40	2.07	6.20	0	19
August.....	76.9	113	37	2.25	4.28	0	7
September.....	67.4	106	25	1.52	6.00	(⁶)	33
October.....	55.0	98	12	.68	2.21	.7	35
November.....	40.4	85	−12	.47	1.40	2.8	47
December.....	32.0	80	−26	.39	.95	3.8	35
Year.....	53.3	114	−29	16.19	6.20	24.1	-----

¹ Average temperature and average precipitation based on a 25-year record, through 1955.² Highest and lowest temperatures based on a 41-year record, through 1959.³ Greatest precipitation in 24-hour period based on a 56-year record, through 1959.⁴ Snowfall based on a 43-year record, through 1959.⁵ Probability based on precipitation records; for example, 36 percent of all Januaries recorded had a precipitation of less than half of 0.40 inch.⁶ Trace.

movements of cold air, this county may have warmer temperatures than areas to the east.

Snowfall is light, and most of it comes late in winter and early in spring. Normally, snows come when the wind shifts to the north. The snow drifts and covers only part of the ground. Because there are frequent warm periods, most snows melt within a few days after falling. March has the largest snowfall of any month. The snows in this month are likely to be wet and sticky, and thus less likely to drift. The ground is bare most of the time in the average winter.

The form of precipitation changes as the spring advances. In March there are wet snows and, occasionally, winds from the east that bring dense clouds and a slow, steady drizzle of rain. Precipitation is more reliable as

spring advances, and it normally reaches a peak in May. There is only one chance in five that rainfall in May will be less than half of the average for that month (see table 15).

In the later part of spring, when the ground is warming most rapidly, the warm air from the ground moves up to meet the cold upper air, and the result is many thunderstorms. Frequently these storms are severe. Late in spring or early in summer, hailstorms strike some part of the county nearly every season. Hail destroys a large acreage of winter wheat. Tornadoes are fewer than to the east, but strong westerly winds frequently cause considerable soil blowing and occasionally bring duststorms.

The average date of the last freezing temperature in spring is early in May, but until about May 18, there is one chance in five that a killing frost will occur. The frost-free season is shorter than in the lower regions to the east of the county.

As summer advances, precipitation decreases. Nevertheless, summer moisture is rather reliable. In the summer months, there is less than one chance in five that the amount of precipitation will be less than 50 percent of average. The pattern and amount of rainfall favor wheat over corn. The rainfall is too light to make corn a dependable crop.

Afternoon temperatures are high during summer, as high or higher than to the east. At this altitude, however, the dry air cools rapidly late in the afternoon and evening. Uncomfortably hot nights are rare. The dry weather is favorable for wheat harvest, but after harvest there frequently are hot, drying winds that sweep the dry stubble fields or bare ground.

Autumn is normally pleasant. Precipitation diminishes rapidly and is very light by November. Most days are mild, but the nights are cool during September, and after the middle of October they are frosty. The first freeze in fall usually comes early in October. There is only one chance in five that freezing temperatures will occur earlier than September 24. The chance is four to one, however, that October 20 will not be reached without a freezing temperature. Brief periods of cold weather, with hard freezing at night, can be expected as early as November 1, and the freezes are more severe and frequent as the month advances. November is normally a month with fine, warm days and frosty nights.

The effect of climate on the agriculture of this county is modified or enhanced in varying degree by the nature of the soils. For example, the coarse sands in the western part of the county absorb rainfall rapidly, so water erosion in that part is seldom a problem. On the silty and fine sandy soils, in the eastern and southern parts, however, water erosion is a serious problem.

Agriculture

Dryland farming and stock raising are the main enterprises in Dundy County. Livestock raising is dominant because there are large areas of native grassland too rough or too sandy for crops. Good production of crops can be achieved on the soils of the loess uplands, in the valley bottoms, and on the flats between the sandhills, provided the level of management is high.

The history of the county has been one of good years and dry years, the effect of which has been enhanced or minimized by attendant conditions, particularly prices for farm commodities. The critical factor has always been supply of moisture.

Irrigation, as a means of supplementing the supply of moisture, is increasing. Some farmers are obtaining irrigation water from the Pioneer Irrigation Ditch, and others obtain water by using electric power to pump deep wells. The Federal Census of Agriculture for 1959 reported 94 irrigated farms in the county. The total land in these farms, irrigated and nonirrigated, was 174,120 acres, and the area irrigated on these farms totaled 10,976 acres. Thus, land in irrigation amounts to about 1.9 percent of the 576,277 acres of land in farms for the entire county.

Land use and types of farms.—In 1959, the total area of Dundy County was reported by the Federal Census as 589,440 acres, and land in farms, as 97.8 percent of this total. The average farm was 1,213.2 acres in size.

In 1959, there were an estimated 11 farms that were not classified by major source of income. The remaining farms were classified by major source of income as follows:

Type of farm:	Number
Livestock, excluding dairy and poultry farms-----	175
Field crop (cash grain) -----	248
Other field crop -----	10
General (cash grain and livestock) -----	26
Dairy -----	5

The long-time trend, as in most parts of the United States, has been toward fewer farms with attendant increase in mechanization.

Livestock.—The Federal Census for 1959 reported 34,097 cattle, 10,141 hogs, 668 horses and mules, and 814 sheep on farms of the county. In 1959, there were 475 farms in the county, and of these, 387 farms reported cattle, 256 farms reported hogs, and 16 farms reported sheep.

Annual reports of the Nebraska Agricultural Statistics, from 1900 to 1957, show that the number of cattle in Dundy County has ranged from about 20,000 to 29,000 head; the number of hogs, from 6,000 to approximately 30,000; the number of horses and mules from nearly 8,000 to less than 1,000, with steady decline since 1920; and the number of sheep, from 6,000 to 8,000 head. The number of poultry has ranged from a low of approximately 33,000 to a high of 69,000.

Crops.—The main crops in this county are corn, wheat, forage sorghum, grain sorghum, and hay. The Federal Census for 1959 reported crops harvested as follows: Corn, 65,989 acres; wheat, 33,796 acres; grain sorghum, 7,553 acres; forage sorghum at 5,830 acres, not including 486 acres cut for silage; alfalfa and alfalfa mixtures for hay, 9,478 acres; and wild hay, 5,480 acres.

According to figures compiled by the Nebraska Agricultural Statistics, in the period 1900 to 1957, the area planted to corn has ranged from about 21,000 to 130,000 acres; the area planted to wheat, from about 3,000 acres to about 55,000 acres; the area in grain sorghum, from about 8,000 acres to 18,000 acres; and the area in forage sorghum from about 2,000 to nearly 25,000. The area in wild hay has ranged from near 5,000 acres to 16,000 acres, and that of alfalfa, from about 1,000 to 18,000 acres. Examination of records for this period shows little in the way of consistent trend toward increase or decrease of any given crop.

In 1959, according to the Federal Census, distribution of crops by farms was as follows: Corn, grown on 351 farms; wheat, on 323 farms; alfalfa and alfalfa mixtures, on 203 farms; grain sorghum on 154 farms; forage sorghum on 192 farms, excluding farms where sorghum was cut for silage; and wild hay on 69 farms.

The distribution on crops by farms perhaps gives better insight into the nature of the agriculture in the county than statistics on acreages of crops planted or harvested. There is considerable variation in acreages sown and harvested from year to year, depending on whether growing conditions are favorable.

Farm tenure.—In 1959, full owners operated 30.3 percent of the farms in the county; part owners, 40.8 percent; managers, 1.5 percent; and tenants, 27.4 percent.

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Glossary

Aggregate (soil). A single mass or cluster that consists of many primary soil particles, such as a block or prism. See Structure, soil.

Alkali soil. A soil that has such a high content of salts, exchangeable sodium, or both, that the growth of most crops is reduced. In popular usage, saline soils are often called "white alkali," and the truly alkaline soils, those that contain exchangeable sodium, are called "black alkali." See Saline soils.

Alluvium. Sediments consisting of sand, silt, and clay that have been deposited by streams.

Blowout. An area in which bare, loose sand is blown about by the wind. Wind carries sand from the loose area to large

areas nearby; hence, a common feature of a blowout is a depression because sand has been removed.

Bottom land. The normal flood plain of a stream, part of which may be flooded infrequently.

Calcareous soil. A soil that contains enough calcium carbonate, or often magnesium carbonate, that it will fizz, or form bubbles, when treated with dilute hydrochloric acid. A soil that is alkaline in reaction because it contains free calcium carbonate.

Caliche. A term for more or less cemented deposits of calcium carbonate.

Clay. Soil grains less than 0.002 millimeter in diameter; or, as a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Mixed deposits of soil material and rock fragments accumulated at the base of rather steep slopes through the influence of gravity, and, in some instances, assisted by flow of water.

Complex (soil). An intricate mixture of areas of at least two different kinds of soil that are too small to be shown separately on maps of the scale used and are, therefore, placed in one mapping unit.

Concretions. Rounded and hardened concentrations of chemical compounds, such as calcium carbonate or iron oxides, often formed as concentric rings about a central particle, in the form of hard grains.

Consistence, soil. The combination of properties of a soil material that determine its resistance to crushing and its ability to be molded or changed in shape. Consistence varies with difference in moisture content; thus, a soil aggregate or clod may be hard when dry and plastic when wet. Terms used to describe consistence are—

Friable. When moist, soil material crushes easily under gentle to moderate pressure between thumb and forefinger and coheres when pressed together. Friable soils are easily tilled.

Firm. When moist, soil material crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable. Firm soils are likely to be difficult to till.

Hard. When dry, soil material is moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.

Indurated. Soil material is hard and brittle; will not soften when moisture is applied.

Loose. Soil material is noncoherent when moist or dry. Loose soils are generally coarse textured and easily tilled.

Plastic. When wet, soil material retains an impressed shape but is deformed by moderate pressure. Plastic soils are high in clay and are difficult to till.

Sticky. When wet, soil material adheres to thumb and forefinger when pressed; normally very cohesive when dry.

Soft. Soil material very weakly coherent and fragile; when dry, breaks to powder or to grains under slight pressure.

Deflocculation. The breakdown, or separation, of soil aggregates containing clay into single particles.

Dispersion (soil). The breaking down of soil aggregates into individual particles of clay, silt, or sand.

Eolian. Carried or produced by wind; for example, eolian sand.

Erosion (soil). The removal of soil material by geologic agencies, principally wind and water. *Accelerated erosion* refers to loss of soil material brought about mainly by the activities of man, and is of three main types: *rill erosion*, *gully erosion*, and *sheet erosion*. Soil blowing, or wind erosion, is also a form of accelerated erosion.

Flocculation. Grouping or coagulation of suspended very fine particles, or colloids, into larger masses that eventually settle out of suspension. Flocculation may aid in formation of soil aggregates but is not identical with aggregation in soils.

Great soil group. A broad group of soils having internal soil characteristics in common. It includes one or more soil families and generally a great number of soil series.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, that has characteristics produced by the soil-forming processes. Horizons are identified by letters of the alphabet, as follows:

A horizon. The horizon at the surface that has lost soluble minerals and clay through the action of percolating waters, or has a dark color because of accumulation of organic

- matter, or shows evidence of both translocation of materials and accumulation of organic matter. The A horizon may be divided into several layers, for example, A₁, A₂, and A₃. An A_p horizon is the part of the A horizon that has been disturbed by cultivation or wind.
- B horizon.** The horizon where clay or other material has accumulated, where natural structural aggregates are present, or both. This horizon may be subdivided; for example, B₁, B₂, B₃.
- C horizon.** The material immediately under the true soil, or solum. In chemical, physical, and mineral composition, this layer is presumed to be similar to the material from which at least part of the overlying soil developed.
- Hummocky.** Pertains to a landscape in which there are hillocks having little or no top, steep side slopes, and low sags between the hillocks. Rolling or undulating relief resembles hummocky relief but has broader ridgetops and longer, more even side slopes.
- Increasers.** Range plants that, in response to grazing, increase in relative amount of forage they produce, as measured from the amount they produced in the climax vegetation.
- Infiltration (soil).** Downward movement of water through the immediate surface of the soil.
- Internal drainage (soil).** Movement of water through the soil profile. Relative terms used to express rate of movement are *none*, *very slow*, *slow*, *medium*, *rapid*, and *very rapid*.
- Invaders.** Range plants that, in response to grazing, invade rangeland and, if grazing is severe, eventually displace both the decreaser and increaser groups of range plants.
- Krotovinas.** Tubes or streaks within a soil layer that have been filled with material from some other layer. Krotovinas appear as rounded spots of various sizes. They are holes dug by burrowing animals and later filled with soil material.
- Leaching.** The removal of soluble constituents, as clay and organic matter, from soils by percolating water.
- Loess.** Geological deposit consisting of fairly uniform, fine material, mostly silt, that presumably was transported by wind.
- Mapping unit.** Any soil, miscellaneous land type, soil complex, or undifferentiated soil group shown on a soil map and identified by a symbol.
- Metamorphic rock.** Rock of any origin that has been so altered by heat, pressure, and movement that its physical nature has been completely changed.
- Morphology (soil).** The physical constitution of the soil, expressed in the kinds of soil horizons, their thickness and arrangement in the profile, and the texture, structure, consistency, porosity, and color of each horizon.
- Mottling (soil).** Patches of a color contrasting to that of the rest of the soil material. Mottles are described according to contrast (*faint*, *distinct*, and *prominent*); abundance (*few*, *common*, and *many*); and size (*fine*, *medium*, and *coarse*). Mottling normally indicates impeded drainage.
- Ogallala formation.** Water-bearing geologic formation that underlies the High Plains; extends to a depth of a few feet to several hundred feet; consists of alluvial outwash of the Pliocene epoch. Formation consists of alternating beds of gravel, sand, and silt, which are cemented with calcium carbonate. The degree of cementation varies. The most noticeable part of this formation, in Dundy County, is the lime rock that outcrops in places.
- Parent material.** The unconsolidated material from which the soil develops; the C horizon.
- Percolation.** The downward movement of water through a porous substance such as soil.
- Phase (soil classification).** A subdivision of the soil type for the purpose of differentiating slope, stoniness, erosion, or some other factor that significantly affects management.
- Pierre shale.** Grayish geologic formation consisting of bedded shale; underlies the Ogallala formation and extends to a depth of several hundred feet; consists of sediments deposited in the seas during the Cretaceous geologic period.
- Profile, soil.** A vertical section through all the horizons of a soil and extending into the parent material. See *Horizon, soil*.
- Quartz.** A mineral low in chemically active compounds and low in soil-forming or clay-forming compounds; the most common of all solid minerals; may be colorless and transparent or colored.
- Reaction (soil).** The degree of acidity or alkalinity of the soil, expressed in pH values or in words. A pH of 7.0 indicates precise neutrality, one of less than 7.0 indicates acidity, and one of more than 7.0 indicates alkalinity.
- Relief.** Elevations or inequalities of the land surface, considered collectively.
- Saline-alkali soil.** A soil that contains soluble salts and is highly alkaline or contains exchangeable sodium in such amounts as to reduce the growth of most crops. Saline-alkali soils look like saline soils so long as the amount of salts exceeds the amount of alkali (sodium). If the excess salts are removed, the sodium reacts with the clay colloids. The clay in the soil then disperses and swells and the soil becomes difficult to irrigate or manage for crops.
- Saline soil.** A soil that contains excess soluble salts, so distributed in the profile as to interfere with the growth of most crops.
- Sand.** Small rock or mineral fragments having diameters of 0.05 millimeter to 2.0 millimeters. Also, the textural name of a soil that contains more than 85 percent of sand and not more than 10 percent of clay.
- Sedimentary (rock).** Rock formed by consolidation of any of many kinds of sediment; for example, sandstone, shale, and limestone.
- Series (soil classification).** A group of soils that, except for texture of the surface layer, have genetic horizons similar, as to differentiating characteristics and arrangement in the soil profile, and developed from a particular type of parent material.
- Silt.** Individual mineral particles in a soil that range in diameter between the upper size of clay, 0.002 millimeter, and the lower size of very fine sand, 0.05 millimeter. Soil of the textural class called silt contains 80 percent or more of silt and less than 12 percent of clay.
- Slope.** The inclination of the land surface from the horizontal; percentage of slope is the vertical distance, divided by horizontal distance, times 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.
- Soil.** The natural medium for the growth of land plants. A natural, three-dimensional body on the surface of the earth, unlike the adjoining bodies. In this report, "soil" is frequently used as a term equivalent to "mapping unit."
- Soil association.** A group of soils, with or without characteristics in common, that occur in a regular, distinguishing pattern.
- Solum.** The part of the soil profile above the parent material; ordinarily, the A and B horizons, or the surface soil and subsoil.
- Structure, soil.** The arrangement of individual soil particles into lumps, granules, or other aggregates. Following are terms for shape of soil structure:
- Blocky, angular.* Aggregates shaped like blocks; surfaces join at sharp angles.
 - Blocky, subangular.* Aggregates have some rounded and some flat surfaces; vertices, or corners, are rounded.
 - Columnar.* Aggregates are prismatic and are rounded at the upper end.
 - Crumb.* Generally soft, small, porous aggregates, irregular in shape but tending toward spherical.
 - Granular.* Roughly spherical, firm, small aggregates that may be either hard or soft but generally are more firm than those having crumb structure; no distinct faces such as those of blocky structure.
 - Platy.* Soil particles arranged around a plane, usually a horizontal plane; platelike.
 - Prismatic.* Soil particles arranged around a vertical plane and having flat vertical surfaces; platelike.
- Substratum.** Any layer beneath the solum, or true soil.
- Tertiary.** A period of geologic time that occurred between 1 million and 60 million years ago. The Pliocene epoch is a part of the period.
- Tilth.** The condition of the soil in terms of its relation to growing a plant or sequence of plants. A soil with good tilth is friable, is porous, and has stable, granular structure; a soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.
- Type (soil classification).** A subdivision of the soil series based on texture of the surface layer.
- Winnowed.** Sifted and sorted by wind. Strong winds remove clay, fine silt, and organic material from the soil and leave the coarser particles; consequently, the soil becomes sandier and more easily eroded.

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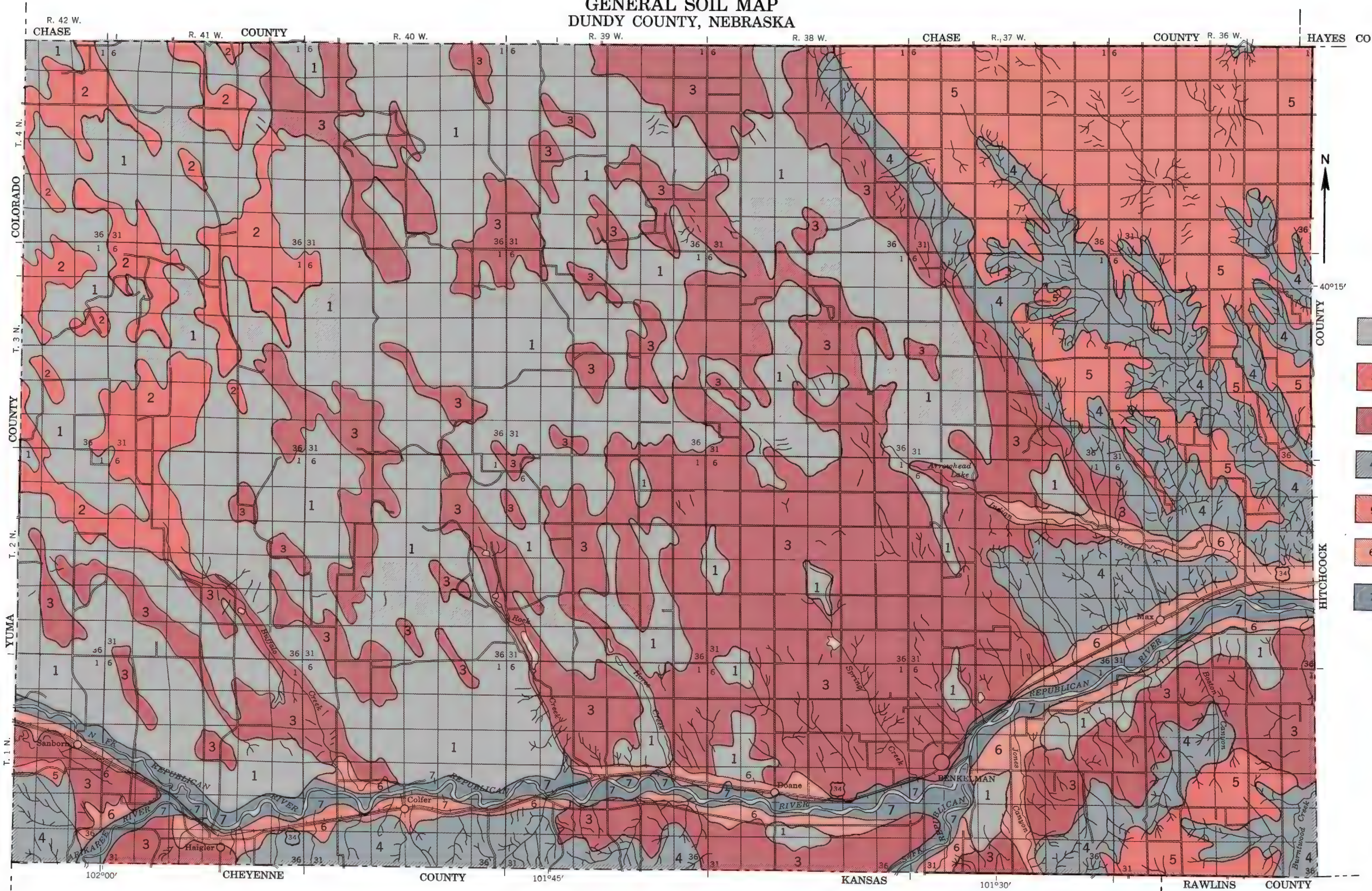
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GENERAL SOIL MAP
DUNDY COUNTY, NEBRASKA

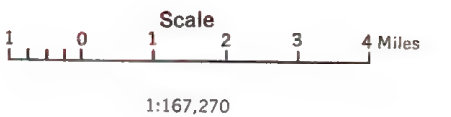
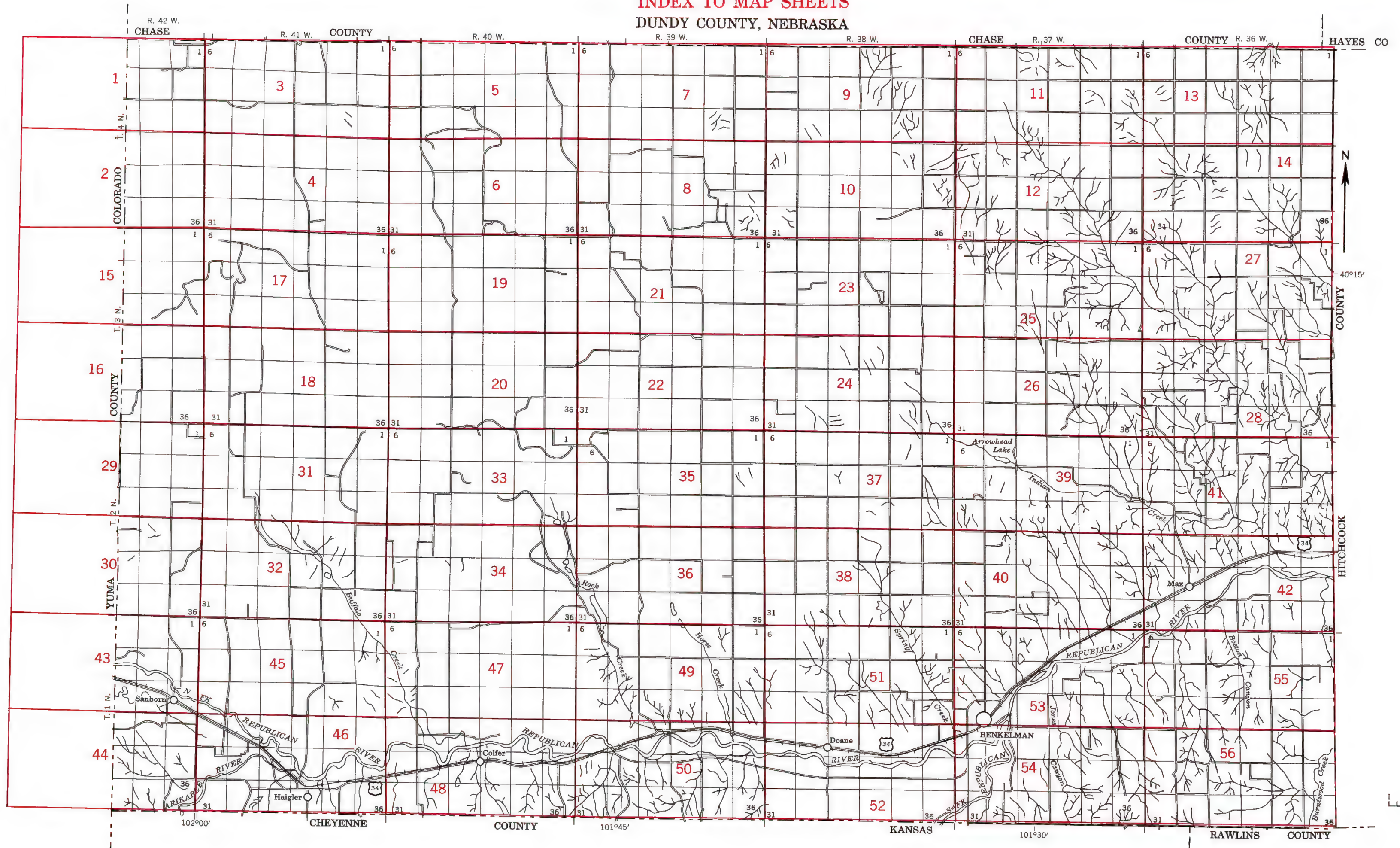


- SOIL ASSOCIATIONS**
- 1 Valentine association:
Soils of sandhills
 - 2 Elsmere-Dunday association:
Sandy soils and sand-caliche soils
of the subirrigated upland valleys
 - 3 Anselmo-Keith association:
Sandy soils, silty soils, and sand-caliche
soils of upland valleys and hills
 - 4 Colby association:
Silty soils of loess hills and canyons
 - 5 Keith association:
Silty soils of loess upland plains
 - 6 Bridgeport-Havre association:
Loamy soils of valley-fill foot
slopes and high bottom lands
 - 7 Sandy alluvial land-Las association:
Sandy and loamy soils of river lowlands



1:167,270

INDEX TO MAP SHEETS
DUNDY COUNTY, NEBRASKA



SOIL LEGEND

Each soil symbol consists of letters, or of letters and numbers; for example, An, BfA2, 2Ke, or 2UC3. The first capital letter is the initial of the soil name. If a number precedes the first capital letter, the soil differs from the one typical of the soil series in depth, position, or some other feature. The second capital letter, except in BCa and BL, indicates the slope of the soil. Symbols for nearly level soils do not have a capital letter to indicate slope, nor do those for miscellaneous land types. A final number, 2 or 3, indicates an eroded soil. A final letter, W, indicates evidence of erosion that has not modified the soil enough to be estimated with reliability.

SYMBOL	NAME	SYMBOL	NAME
An	Anselmo fine sandy loam, 0 to 1 percent slopes	2Ke	Keith silt loam, thick, 0 to 1 percent slopes
AnA	Anselmo fine sandy loam, 1 to 3 percent slopes	4Ke	Keith silt loam, caliche substratum, 0 to 1 percent slopes
AnB	Anselmo fine sandy loam, 3 to 5 percent slopes	2KeA	Keith silt loam, thick, 1 to 3 percent slopes
AnC	Anselmo fine sandy loam, 5 to 9 percent slopes	KeB2	Keith silt loam, 3 to 5 percent slopes, eroded
AnC2	Anselmo fine sandy loam, 5 to 9 percent slopes, eroded	KfAW	Keith fine sandy loam, 1 to 3 percent slopes
AnD	Anselmo fine sandy loam, 9 to 30 percent slopes	2KfA	Keith fine sandy loam, thick, 1 to 3 percent slopes
AoAW	Anselmo loamy fine sand, 0 to 3 percent slopes	KfB2	Keith fine sandy loam, 3 to 5 percent slopes, eroded
AoBW	Anselmo loamy fine sand, 3 to 5 percent slopes	2Kf	Keith fine sandy loam, thick, 0 to 1 percent slopes
B	Blown-out land	4Kf	Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes
Bb	Banks fine sand	4KfW	Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes
Bc	Banks loamy fine sand		
BCa	Rough broken land, caliche	Ln	Las Animas loamy fine sand
Bf	Bayard fine sandy loam, 0 to 1 percent slopes	LS	Laurel soils
BfA	Bayard fine sandy loam, 1 to 3 percent slopes	2Ls	Las fine sandy loam, saline-alkali
BfA2	Bayard loamy fine sand, wind-hummocky	2Lt	Las loam, saline-alkali
Bh	Bridgeport loam, 0 to 1 percent slopes	Ov	Ovina fine sandy loam, 0 to 1 percent slopes
BhA	Bridgeport loam, 1 to 3 percent slopes	Pt	Platte loam
BhB	Bridgeport loam, 3 to 5 percent slopes	Ra	Rauville loam
BL	Rough broken land, loess	Sc	Scott silt loam
CdCW	Colby loam, 3 to 9 percent slopes	Sx	Sandy alluvial land
CdDW	Colby loam, 9 to 30 percent slopes	Sy	Broken alluvial land
CgB	Canyon fine sandy loam, 3 to 5 percent slopes	UsC	Ulysses silt loam, 5 to 9 percent slopes
Du	Dunday loamy fine sand	UsC2	Ulysses silt loam, 5 to 9 percent slopes, eroded
2Du	Dunday loamy fine sand, loam substratum	2UC2	Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded
Es	Elsmere fine sandy loam, 0 to 1 percent slopes	2UC3	Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded
EsC	Elsmere fine sandy loam, 1 to 5 percent slopes		
Ga	Gannett fine sandy loam	VaC	Valentine fine sand, rolling
Gd	Glendive fine sandy loam	VaD	Valentine fine sand, hilly
Gf	Goshen fine sandy loam, 0 to 1 percent slopes	Vb	Valentine loamy fine sand
Gh	Goshen silt loam, 0 to 1 percent slopes	3VfA	Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes
Hf	Havre fine sandy loam		
Hh	Havre loam		
KeAW	Keith silt loam, 1 to 3 percent slopes		

WORKS AND STRUCTURES

Highways and roads	
Dual	
Good motor	
Poor motor	
Trail	
Highway markers	
National Interstate	
U. S.	
State	
Railroads	
Single track	
Multiple track	
Abandoned	
Bridges and crossings	
Road	
Trail, foot	
Railroad	
Ferries	
Ford	
Grade	
R. R. over	
R. R. under	
Tunnel	
Buildings	
School	
Church	
Station	
Mines and Quarries	
Mine dump	
Pits, gravel or other	
Power lines	
Pipe lines	
Cemeteries	
Dams	
Levees	
Tanks	
Oil wells	
Windmills	

CONVENTIONAL SIGNS

BOUNDARIES	
National or state	
County	
Township, U. S.	
Section line, corner	
Reservation	
Land grant	

SOIL SURVEY DATA

Soil boundary	
and symbol	
Gravel	
Stones	
Rock outcrops	
Chert fragments	
Clay spot	
Sand spot	
Gumbo or scabby spot	
Made land	
Severely eroded spot	
Blowout, wind erosion	
Gullies	
Short steep slope	

DRAINAGE

Streams	
Perennial	
Intermittent, unclass.	
Canals and ditches	
Perennial	
Intermittent	
Lakes and ponds	
Perennial	
Intermittent	
Wells	
Springs	
Marsh	
Wet spot	

RELIEF

Escarpments	
Bedrock	
Other	
Prominent peaks	
Large	
Small	
Depressions	

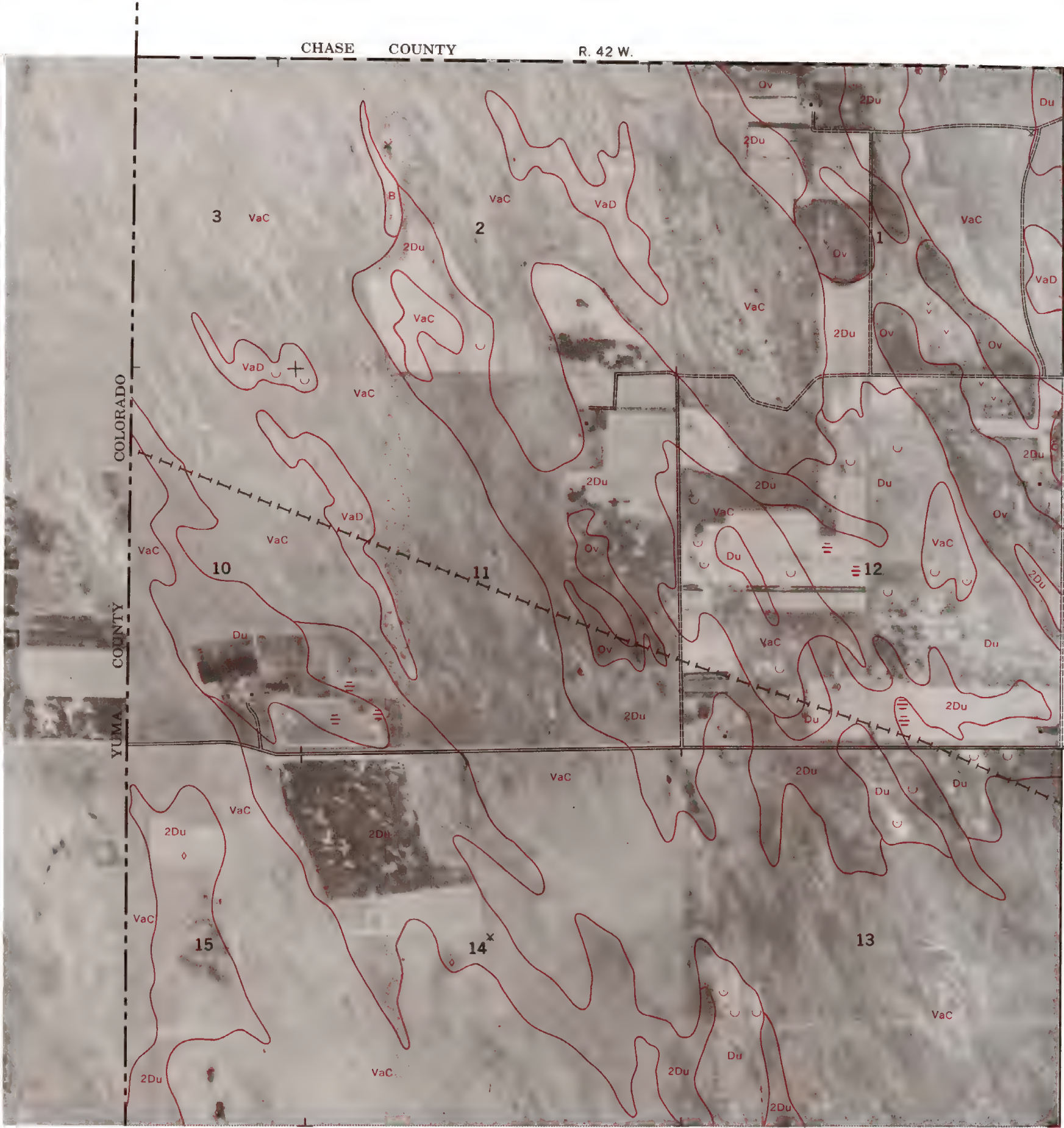
GUIDE TO MAPPING UNITS, CAPABILITY UNITS, RANGE SITES, AND WOODLAND SITES

[See table 1, p. 22, for estimated crop yields, and table 10, p. 50, for the approximate acreage and proportionate extent of the soils]

Map- ping unit	Soil	Page	Capability unit				Range site		Woodland site		Map- ping unit	Soil	Page	Capability unit				Range site		Woodland site	
			Dry- land	Page	Irri- gated	Page	Name	Page	Name	Page				Dry- land	Page	Irri- gated	Page	Name	Page	Name	Page
An	Anselmo fine sandy loam, 0 to 1 percent slopes.	51	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33	KeAW	Keith silt loam, 1 to 3 percent slopes.....	62	IIe-1	14	IIe-1	19	Silty	27	Silty to Clayey.	33
AnA	Anselmo fine sandy loam, 1 to 3 percent slopes.	52	IIIe-3	15	IIe-3	20	Sandy	27	Sandy	33	2Ke	Keith silt loam, thick, 0 to 1 percent slopes.	62	IIe-1	14	I-1	19	Silty	27	Silty to Clayey.	33
AnB	Anselmo fine sandy loam, 3 to 5 percent slopes.	52	IIIe-3	15	IIIe-3	20	Sandy	27	Sandy	33	4Ke	Keith silt loam, caliche substratum, 0 to 1 percent slopes.	62	IIe-1	14	I-1	19	Silty	27	Silty to Clayey.	33
AnC	Anselmo fine sandy loam, 5 to 9 percent slopes.	52	IVe-3	16	IVe-3	21	Sandy	27	Sandy	33	2KeA	Keith silt loam, thick, 1 to 3 percent slopes.	62	IIe-1	14	IIe-1	19	Silty	27	Silty to Clayey.	33
AnC2	Anselmo fine sandy loam, 5 to 9 percent slopes, eroded.	52	IVe-3	16	IVe-3	21	Sandy	27	Sandy	33	KeB2	Keith silt loam, 3 to 5 percent slopes, eroded.	62	IIIe-1	15	IIIe-1	20	Silty	27	Silty to Clayey.	33
AnD	Anselmo fine sandy loam, 9 to 30 percent slopes.	52	VIe-3	17			Sandy	27	Sandy	33	KfAW	Keith fine sandy loam, 1 to 3 percent slopes..	61	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33
AoAW	Anselmo loamy fine sand, 0 to 3 percent slopes.	52	IIIe-3	15	IIe-3	20	Sandy	27	Sandy	33	2KfA	Keith fine sandy loam, thick, 1 to 3 percent slopes.	62	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33
AoBW	Anselmo loamy fine sand, 3 to 5 percent slopes.	52	IIIe-3	15	IIIe-3	20	Sandy	27	Sandy	33	KfB2	Keith fine sandy loam, 3 to 5 percent slopes, eroded.	61	IIIe-3	15	IIIe-3	20	Sandy	27	Sandy	33
B	Blown-out land.....	54	VIe-5	17			Sands	26	Very Sandy	33	2Kf	Keith fine sandy loam, thick, 0 to 1 percent slopes.	61	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33
Bb	Banks fine sand.....	53	VIe-5	17			Sands	26	Very Sandy	33	4Kf	Keith fine sandy loam, caliche substratum, 0 to 1 percent slopes.	61	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33
Bc	Banks loamy fine sand.....	53	IVe-5	16	IVe-5	21	Sandy	27	Sandy	33	4KfW	Keith fine sandy loam, caliche substratum, 1 to 3 percent slopes.	61	IIIe-3	15	IIe-3	20	Sandy	27	Sandy	33
BCa	Rough broken land, caliche.....	66	VIIIs-3	18			Thin Breaks	28	(Not plant-able.)	34	Ln	Las Animas loamy fine sand.....	64	IVw-5	16	IVw-5	21	Subirrigated	26	Moderately Wet.	34
Bf	Bayard fine sandy loam, 0 to 1 percent slopes.	54	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33	LS	Laurel soils.....	65	VIIs-1	18			Saline Lowland	26	(Not plant-able.)	34
BfA	Bayard fine sandy loam, 1 to 3 percent slopes.	54	IIIe-3	15	IIe-3	20	Sandy	27	Sandy	33	2Ls	Las fine sandy loam, saline-alkali.....	63	IVs-1	17	IIIs-1	21	Subirrigated	26	Moderately Saline-Alkali.	34
BfA2	Bayard loamy fine sand, wind-hummocky..	54	IIIe-3	15	IIe-3	20	Sandy	27	Sandy	33	2Lt	Las loam, saline-alkali.....	63	IVs-1	17	IIIs-1	21	Subirrigated	26	Moderately Saline-Alkali.	34
Bh	Bridgeport loam, 0 to 1 percent slopes....	55	IIe-1	14	I-1	19	Silty	27	Silty to Clayey.	33	Ov	Ovina fine sandy loam, 0 to 1 percent slopes.	65	IVw-6	16	IIIw-6	20	Subirrigated	26	Moderately Wet.	34
BhA	Bridgeport loam, 1 to 3 percent slopes....	55	IIe-1	14	IIe-1	19	Silty	27	Silty to Clayey.	33	Pt	Platte loam.....	66	Vw-1	17			Subirrigated	26	Wet	34
BhB	Bridgeport loam, 3 to 5 percent slopes....	55	IIIe-1	15	IIIe-1	20	Silty	27	Silty to Clayey.	33	Ra	Rauville loam.....	66	Vw-1	17			Wet Land	25	Wet	34
BL	Rough broken land, loess.....	67	VIIe-1	18			Thin Loess	28	Silty to Clayey.	33	Sc	Scott silt loam.....	67	VIw-1	18			Overflow	26	Wet	34
CdCW	Colby loam, 3 to 9 percent slopes.....	56	IVe-1	15			Silty	27	Silty to Clayey.	33	Sx	Sandy alluvial land.....	50	VIw-1	18			Overflow	26	Moderately Wet.	34
CdDW	Colby loam, 9 to 30 percent slopes.....	56	VIe-1	17			Silty	27	Silty to Clayey.	33	Sy	Broken alluvial land.....	50	VIw-1	18			Overflow	26	Moderately Wet.	34
CgB	Canyon fine sandy loam, 3 to 5 percent slopes.	55	VIIs-4	18			Shallow	28	Shallow	34	UsC	Ulysses silt loam, 5 to 9 percent slopes....	68	IVe-1	15	IVe-1	21	Silty	27	Silty to Clayey.	33
Du	Dunday loamy fine sand.....	57	IVe-5	16	IVe-5	21	Sandy	27	Sandy	33	UsC2	Ulysses silt loam, 5 to 9 percent slopes, eroded.	68	IVe-1	15	IVe-1	21	Silty	27	Silty to Clayey.	33
2Du	Dunday loamy fine sand, loam substratum..	57	IVe-5	16	IVe-5	21	Sandy	27	Sandy	33	2UC2	Ulysses loam, clay substratum variant, 3 to 7 percent slopes, eroded.	69	IIIe-1	15	IIIe-1	20	Silty	27	Silty to Clayey.	33
Es	Elsmere fine sandy loam, 0 to 1 percent slopes.	58	IVw-5	16	IVw-5	21	Subirrigated	26	Moderately Wet.	34	2UC3	Ulysses clay loam, clay substratum variant, 5 to 9 percent slopes, severely eroded.	69	VIe-1	17			Silty	27	Silty to Clayey.	33
EsC	Elsmere fine sandy loam, 1 to 5 percent slopes.	58	VIw-5	18			Subirrigated	26	Moderately Wet.	34	VaC	Valentine fine sand, rolling.....	70	VIe-5	17			Sands	26	Very Sandy	33
Ga	Gannett fine sandy loam.....	58	Vw-1	17			Wet Land	25	Wet	34	VaD	Valentine fine sand, hilly.....	69	VIIe-5	18			Choppy Sands.	26	Very Sandy	33
Gd	Glendive fine sandy loam.....	59	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33	Vb	Valentine loamy fine sand.....	70	VIe-5	17			Sands	26	Very Sandy	33
Gf	Goshen fine sandy loam, 0 to 1 percent slopes.	59	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33	3ViA	Vebar fine sandy loam, moderately deep, 0 to 3 percent slopes.	70	IVe-3	16	IIe-3	20	Sandy	27	Sandy	33
Gh	Goshen silt loam, 0 to 1 percent slopes....	59	IIe-1	14	I-1	19	Silty	27	Silty to Clayey.	33											
Hf	Havre fine sandy loam.....	60	IIe-3	14	IIe-3	20	Sandy	27	Sandy	33											
Hh	Havre loam.....	60	IIe-1	14	I-1	19	Silty	27	Silty to Clayey.	33											

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Range, township, and section corners shown on this map are indefinite.



(Joins sheet 3)

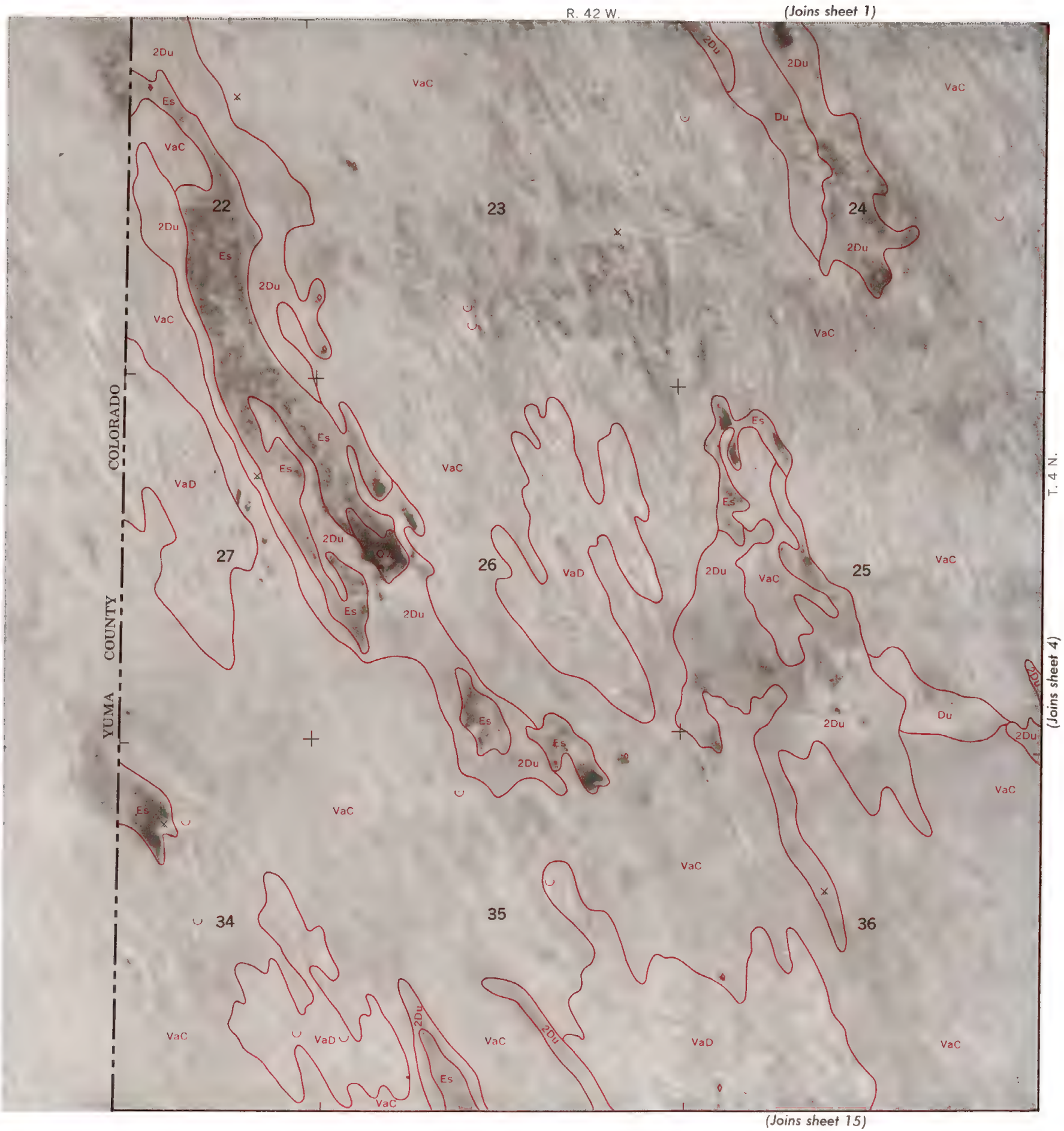
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2

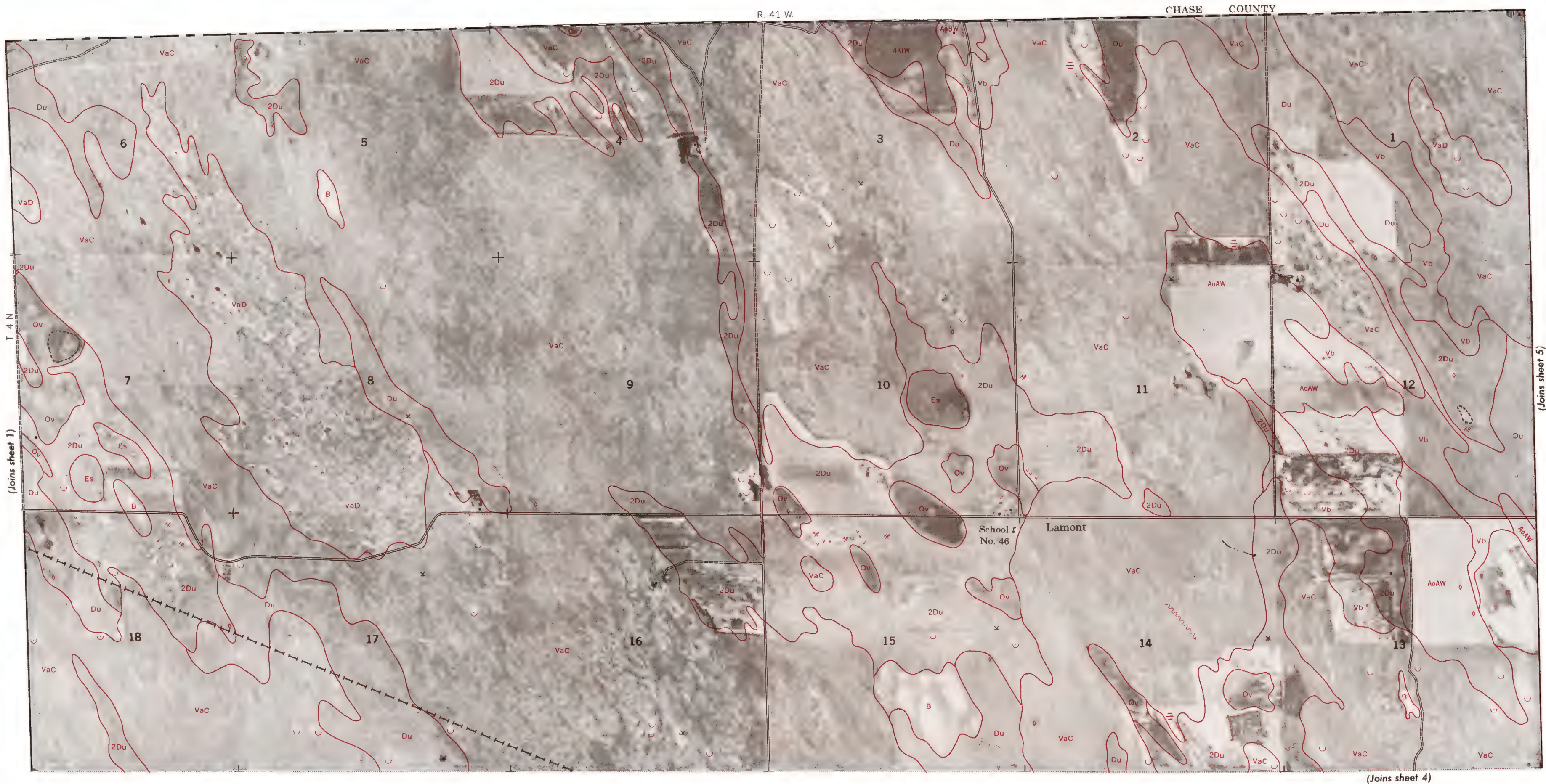


L



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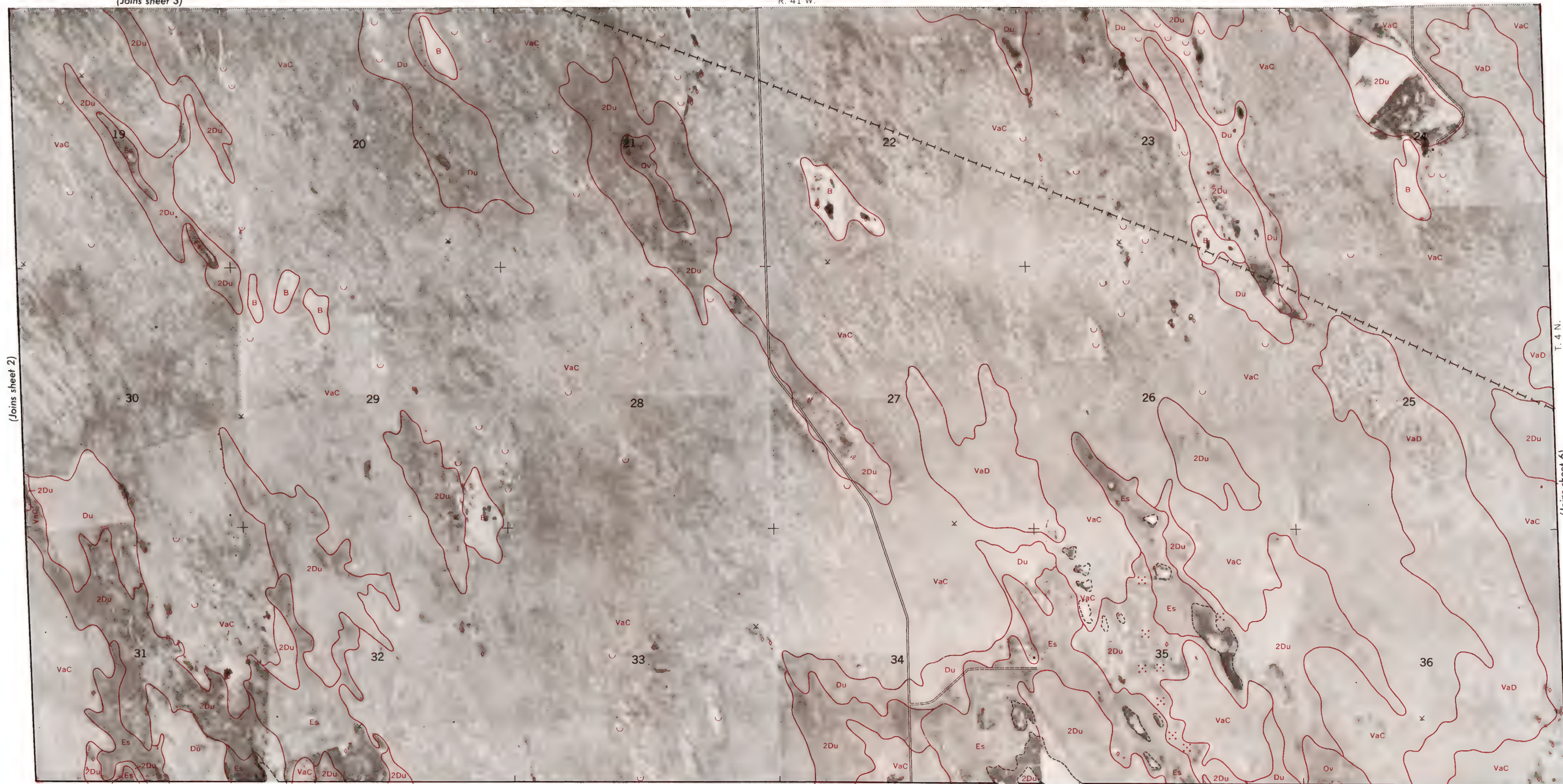
4

(Joins sheet 3)

R. 41 W.



(Joins sheet 2)



(Joins sheet 17)

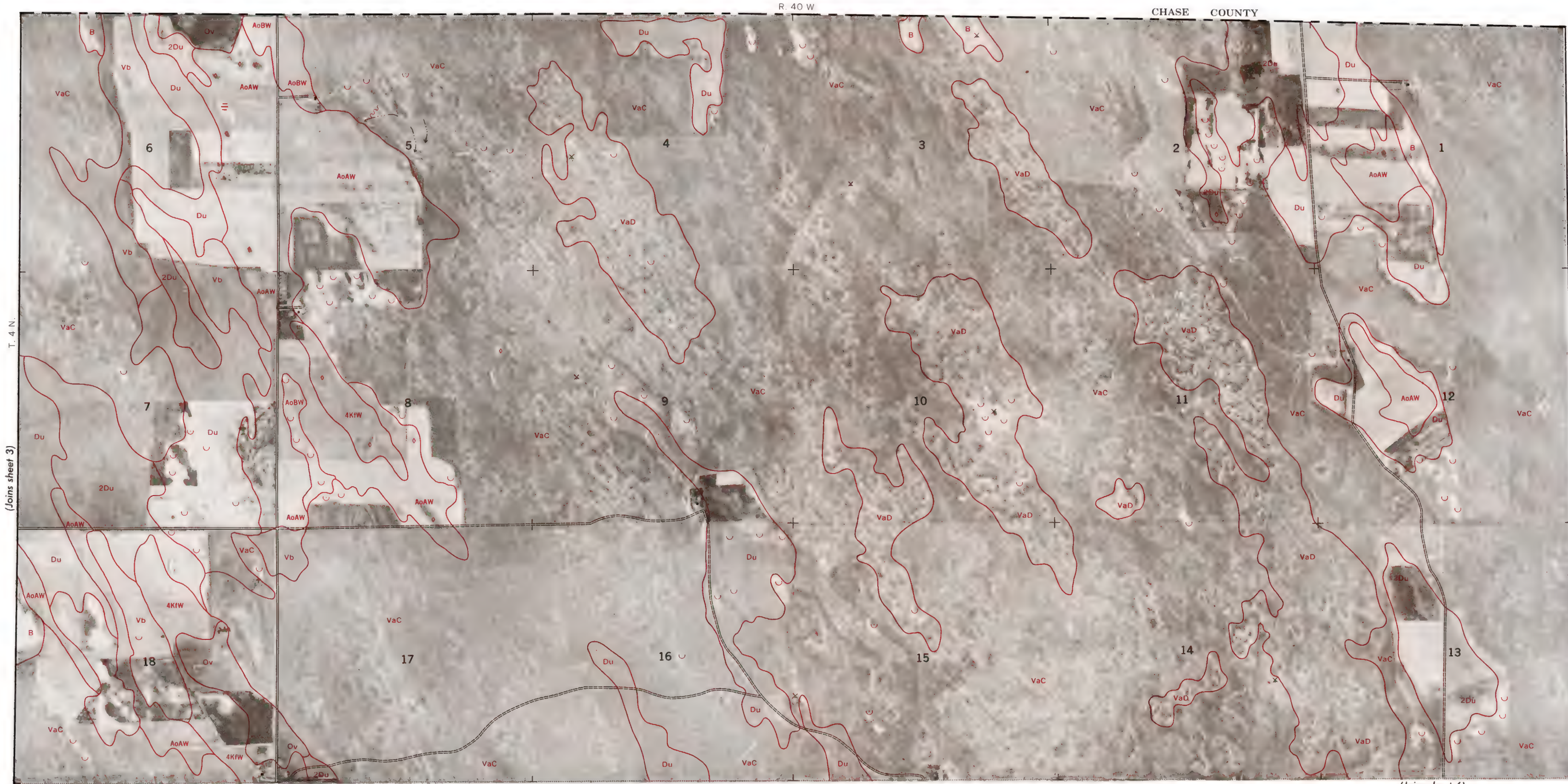
T. 4 N.

(Joins sheet 6)



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(Joins sheet 3)

(Joins sheet 7)

(Joins sheet 6)



R. 40 W

N

(Joins sheet 4)

T. 4 N.

(Joins sheet 8)

0 $\frac{1}{4}$ 1 Mile Scale 1:20 000 0 5 000 Feet

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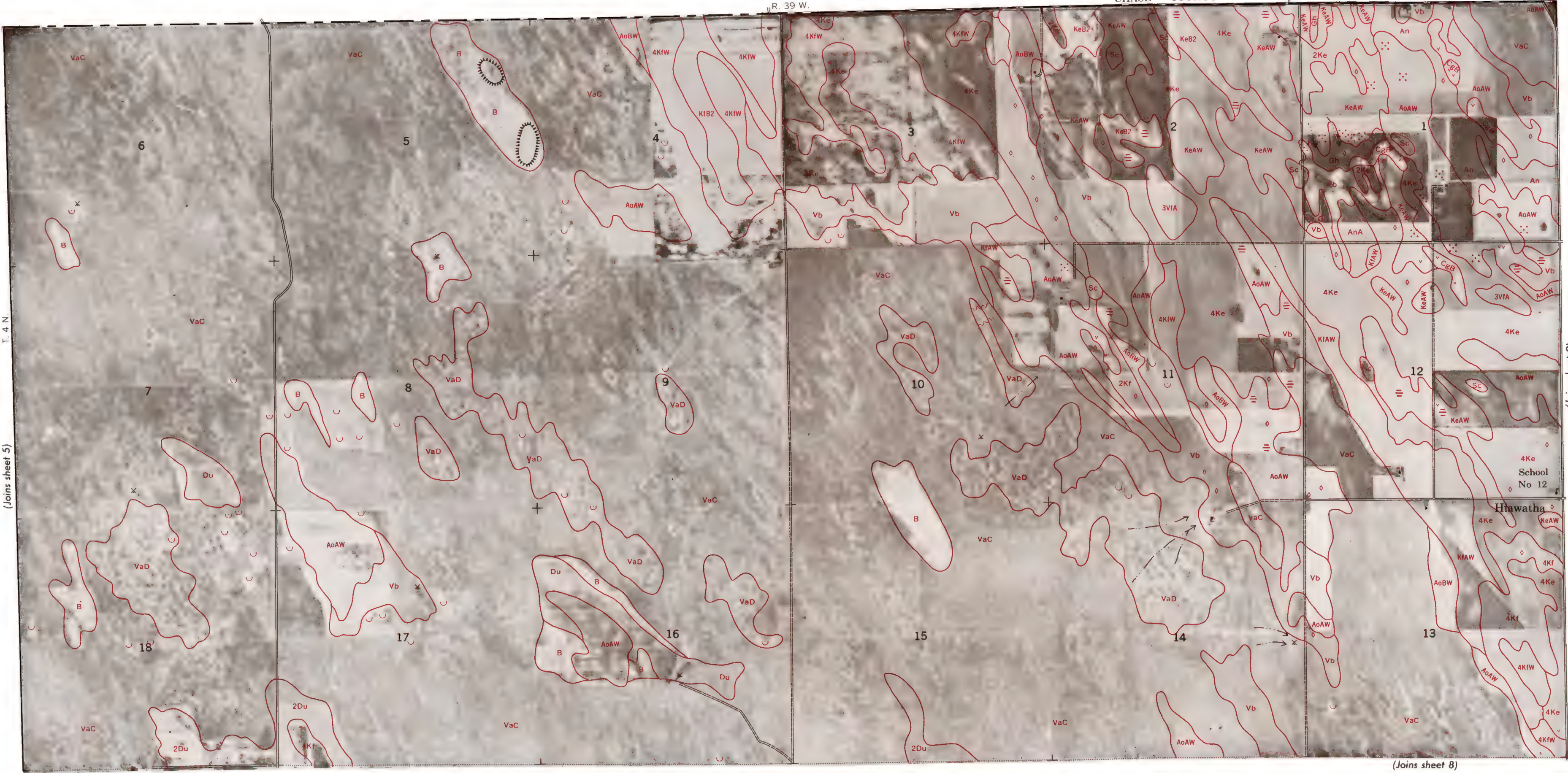
Range, township, and section corners shown on this map are indefinite.

(Joins sheet 5)

T. 4 N.

R. 39 W.

CHASE COUNTY



(Joins sheet 9)

(Joins sheet 8)



8

(Joins sheet 7)

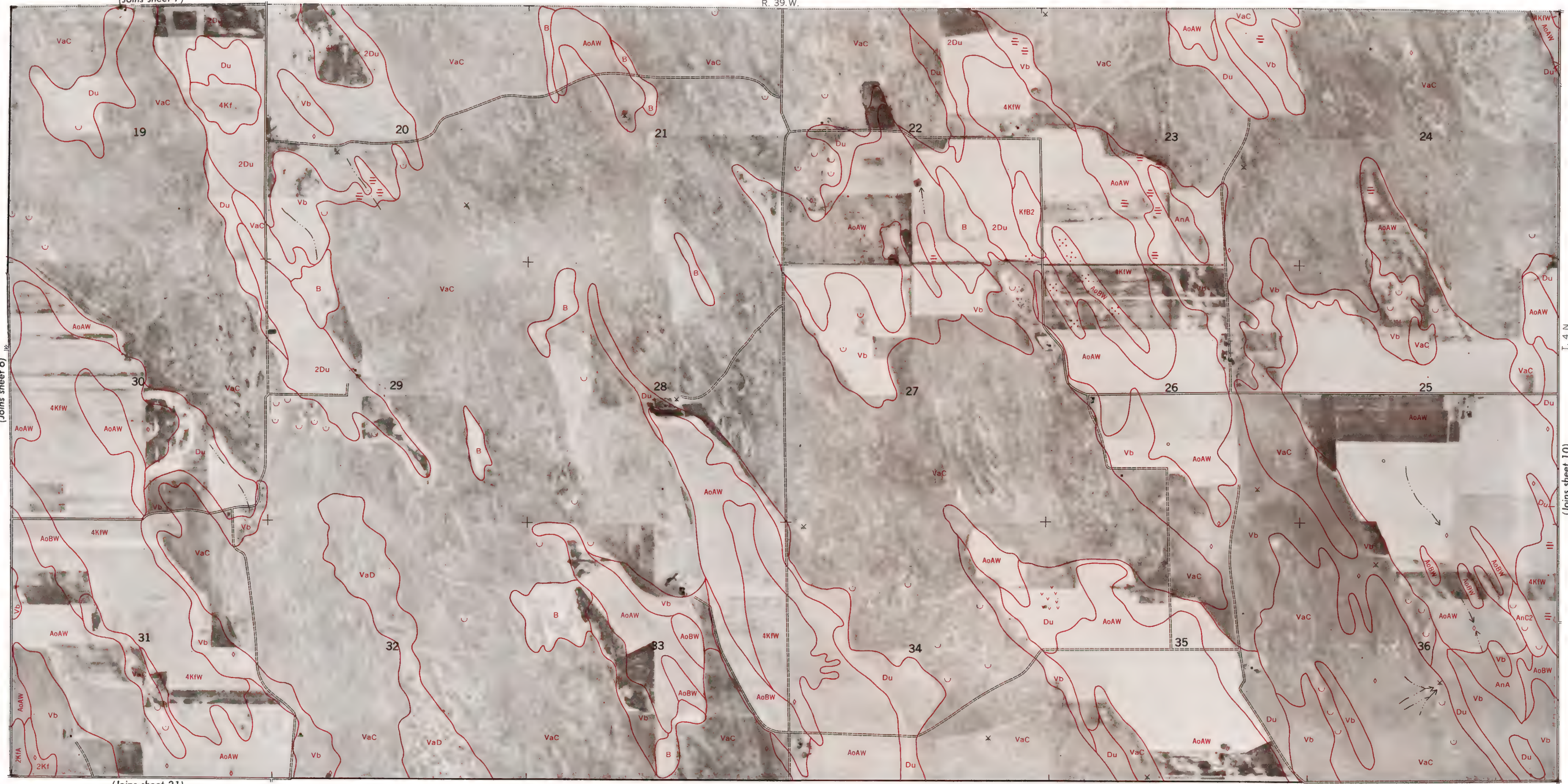
R. 39. W.



(Joins sheet 6)

T. 4 N.

(Joins sheet 10)



(Joins sheet 21)



Range, township, and section corners shown on this map are indefinite.



R. 38 W.



(Joins sheet 8)

T. 4 N.

(Joins sheet 12)



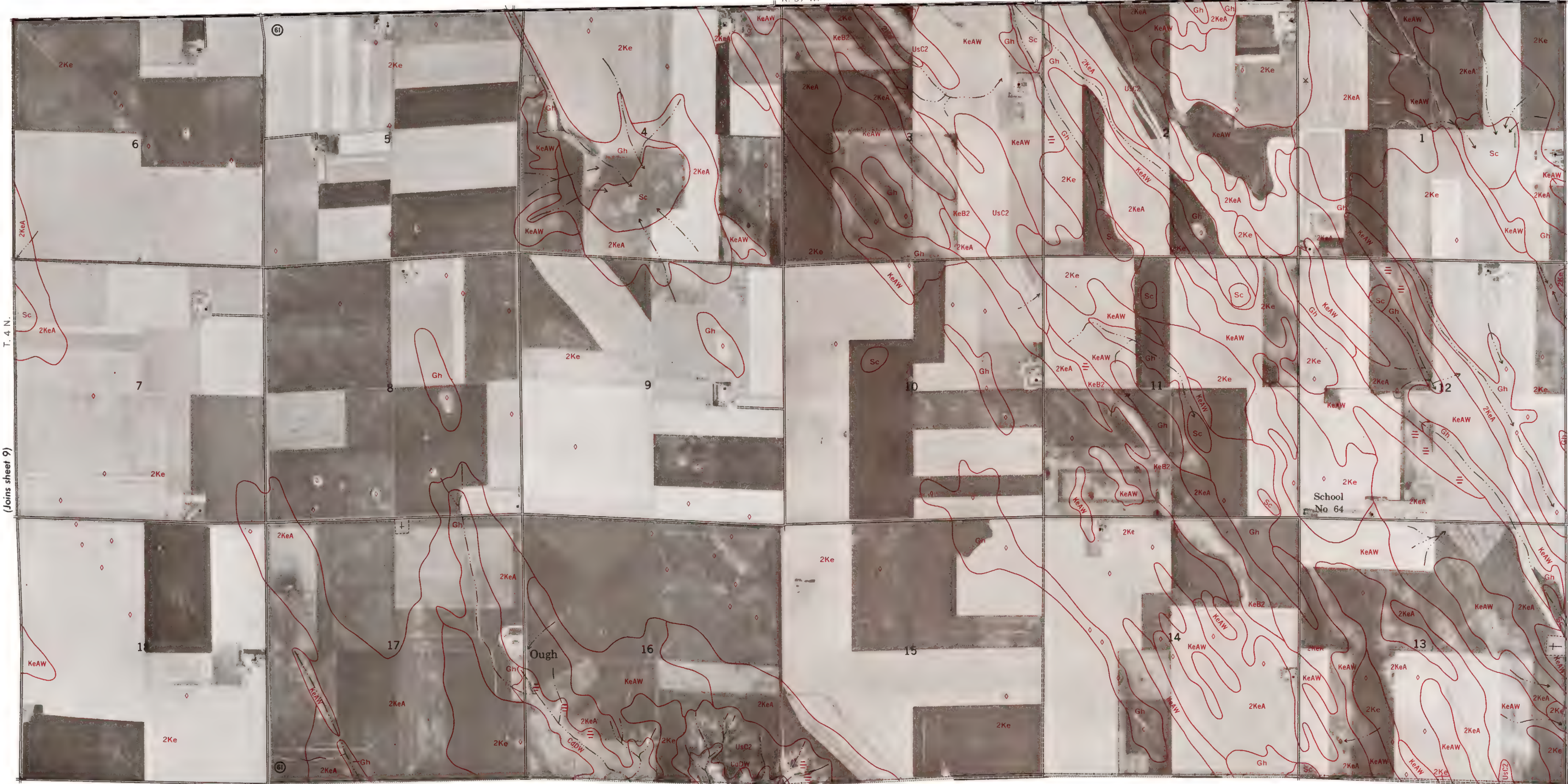
R. 37 W.

CHASE COUNTY



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(Joins sheet 9)

(Joins sheet 13)

(Joins sheet 12)



R. 37 W.

(Joins sheet 70)

T. 4. N.

(Joins sheet 74)

R. 36 W.

CHASE COUNTY

HAYES COUNTY

HITCHCOCK COUNTY



(Joins sheet 11)

(Joins sheet 14)



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14

(Joins sheet 13)

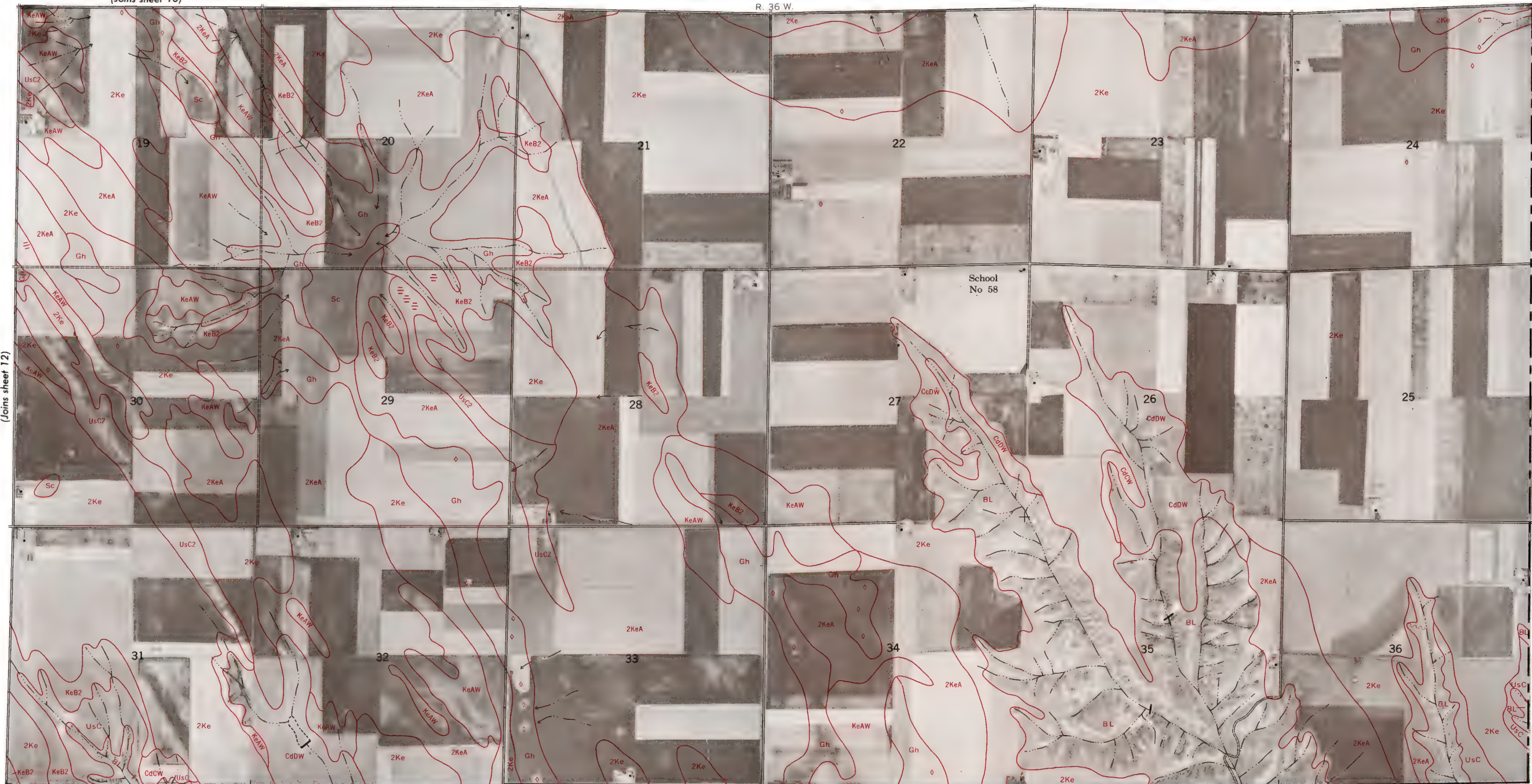
R. 36 W.



(Joins sheet 12)

T. 4 N.

HITCHCOCK COUNTY

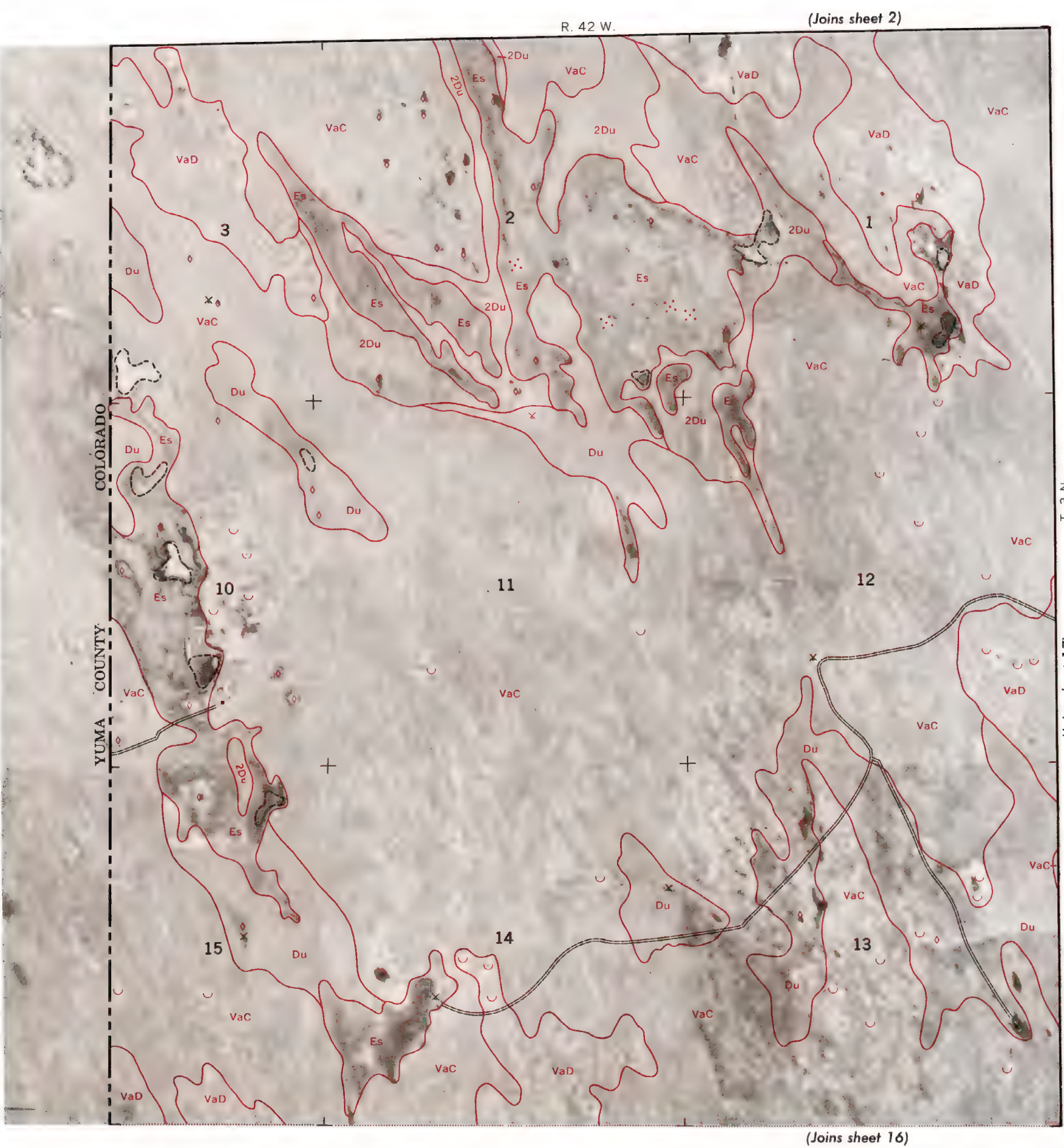


(Joins sheet 27)

0 1/4 1 Mile Scale 1:20 000 0 5 000 Feet

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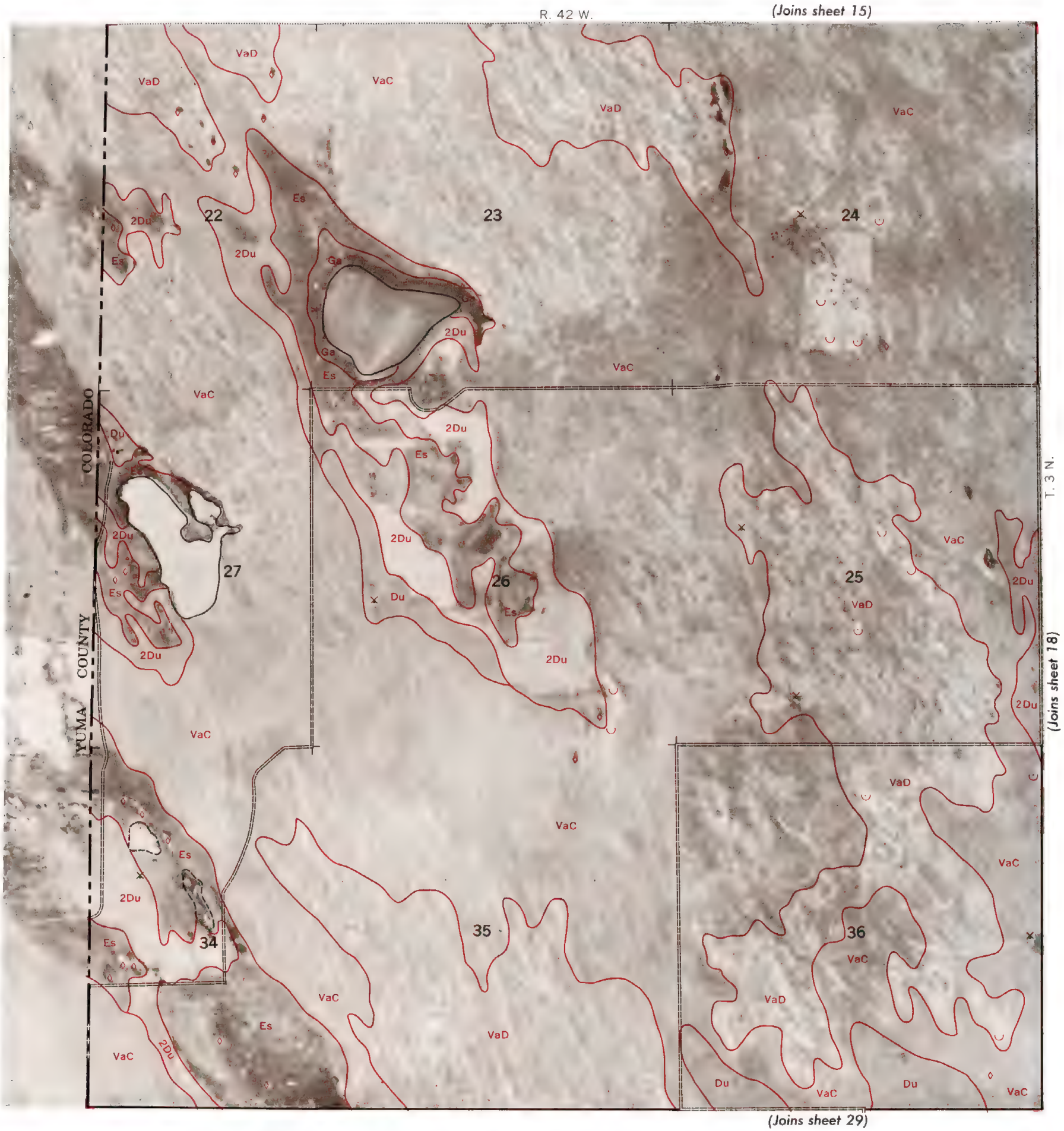
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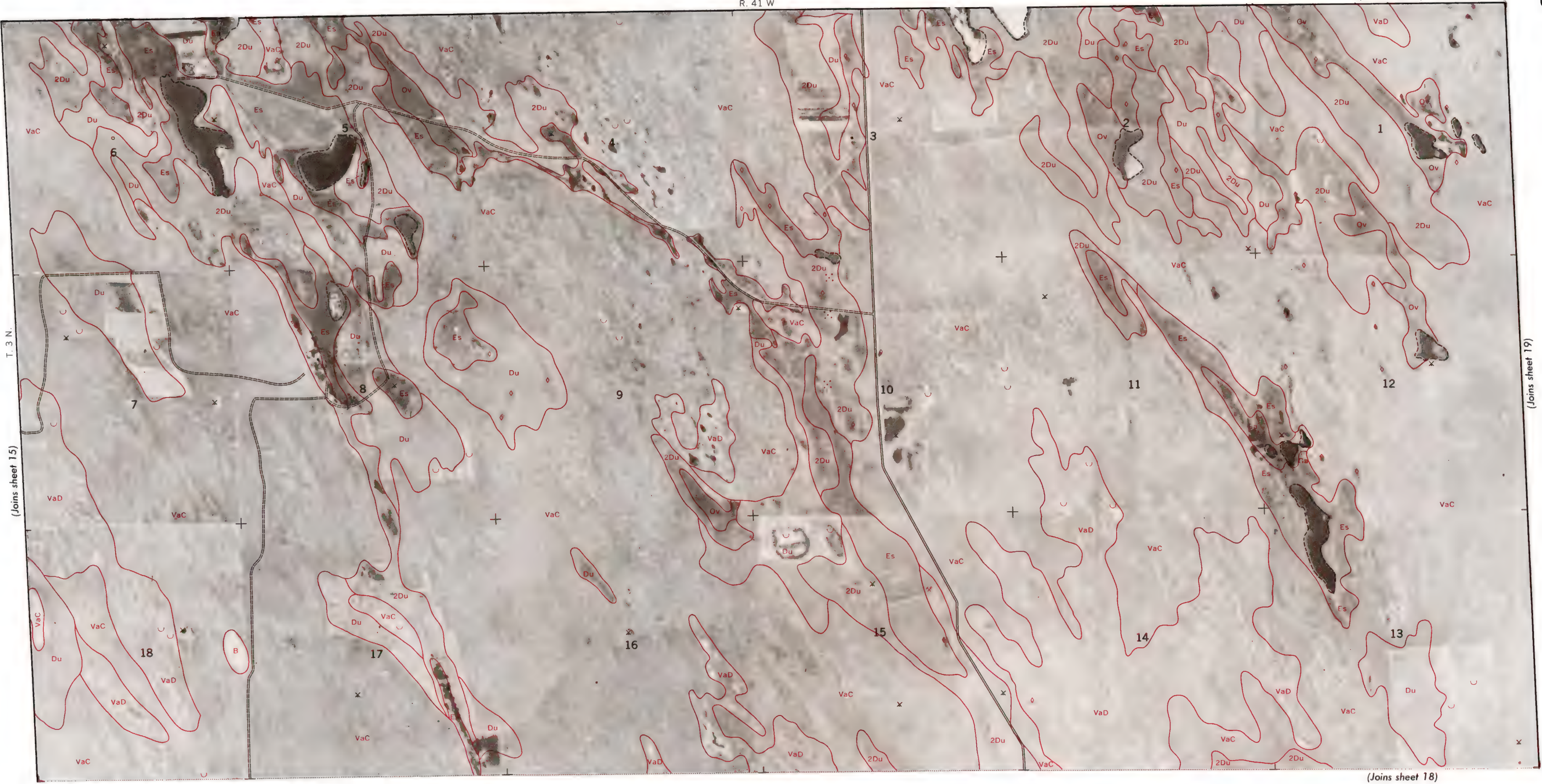
16



L



0 1/2 1 Mile Scale 1:20 000 0 5 000 Feet



(Joins sheet 15)

(Joins sheet 19)

(Joins sheet 18)



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Range, township, and section corners shown on this map are indefinite.

18

(Joins sheet 17)

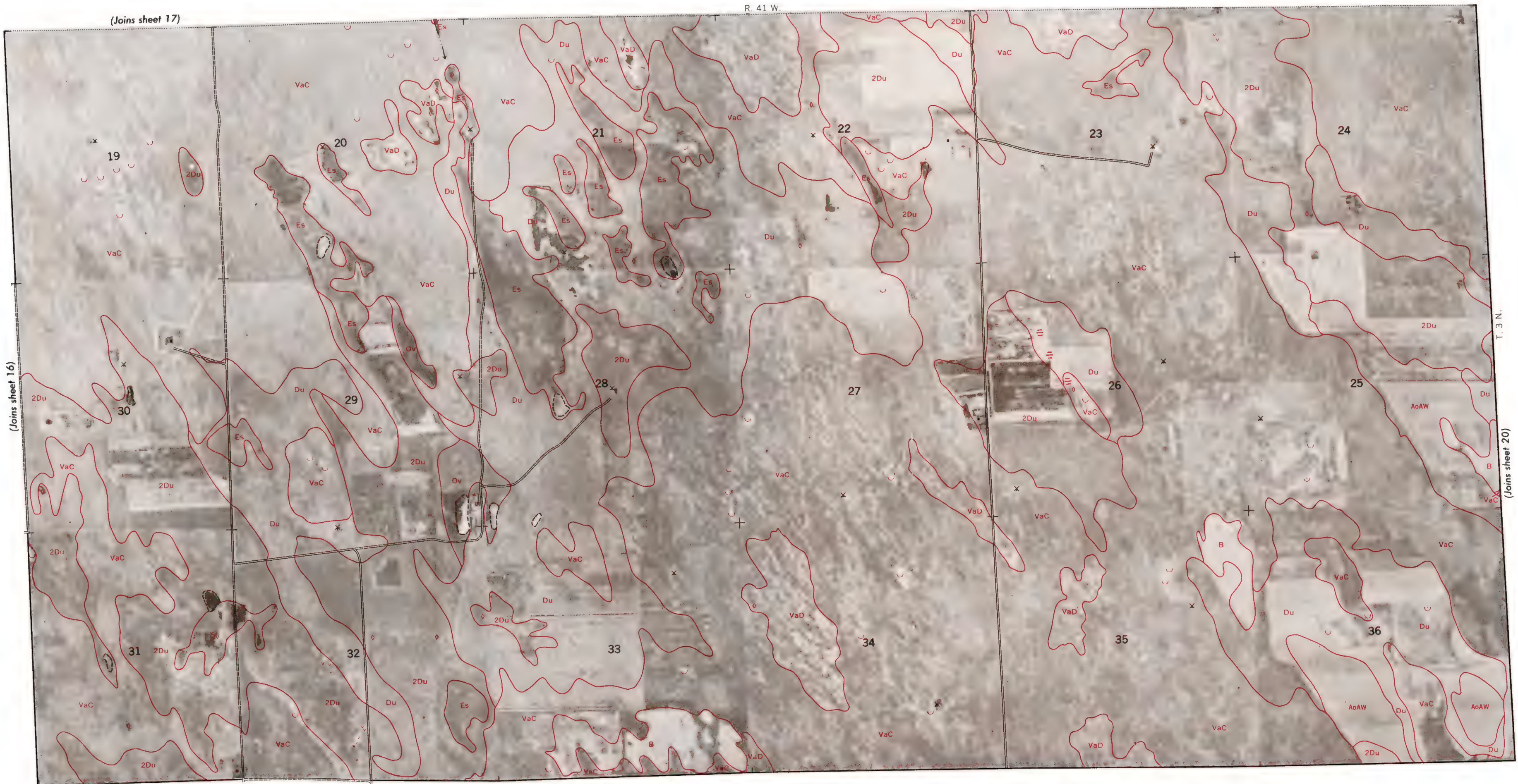
R. 41 W.



(Joins sheet 16)

T. 3 N.

(Joins sheet 20)



(Joins sheet 31)



R. 40 W.

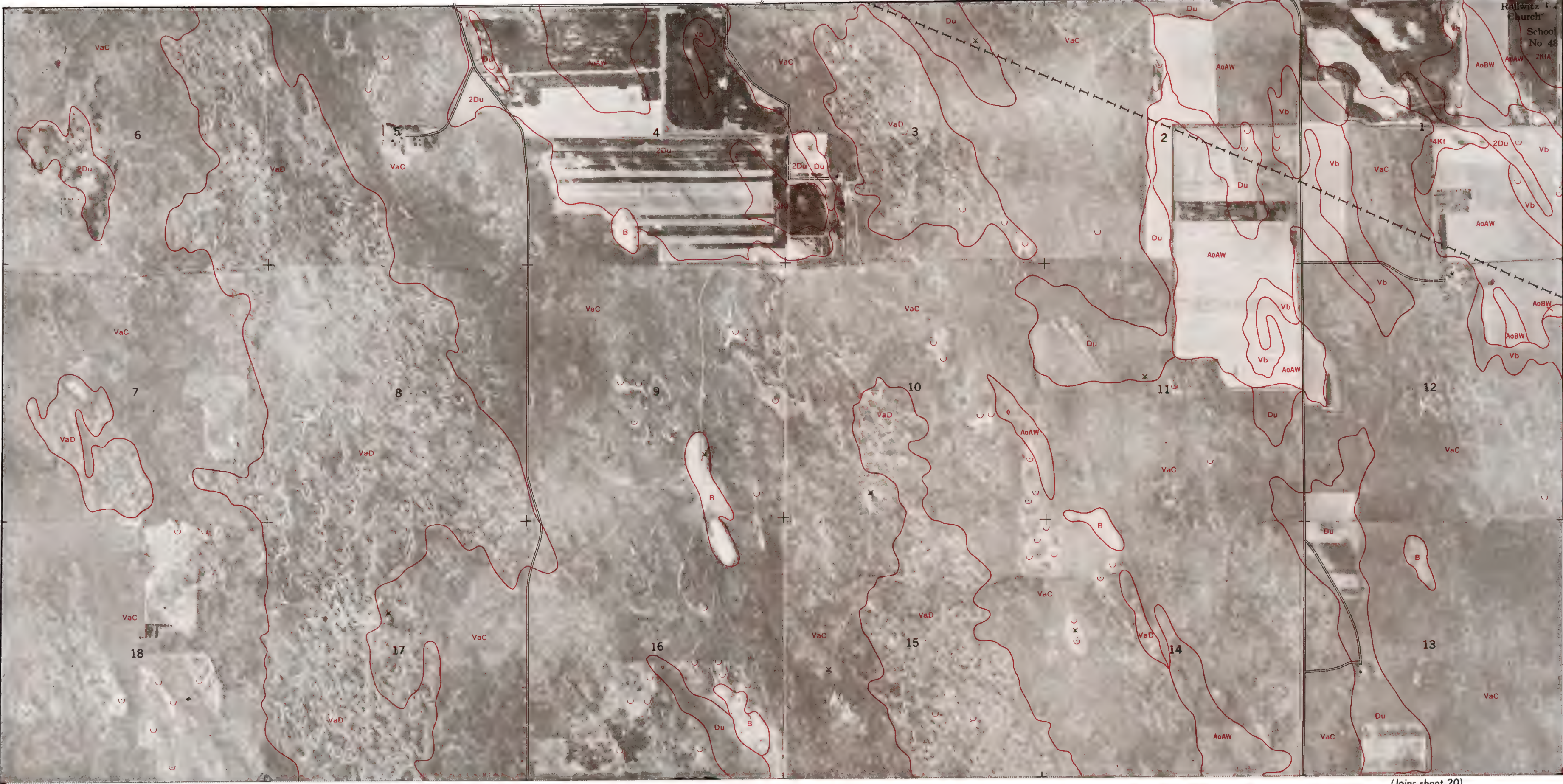
(Joins sheet 6)

19



(Joins sheet 21)

(Joins sheet 20)



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Range, township, and section corners shown on this map are indefinite.

(Joins sheet 17)



R. 40 W.



...



R. 39 W.

(Joins sheet 8)

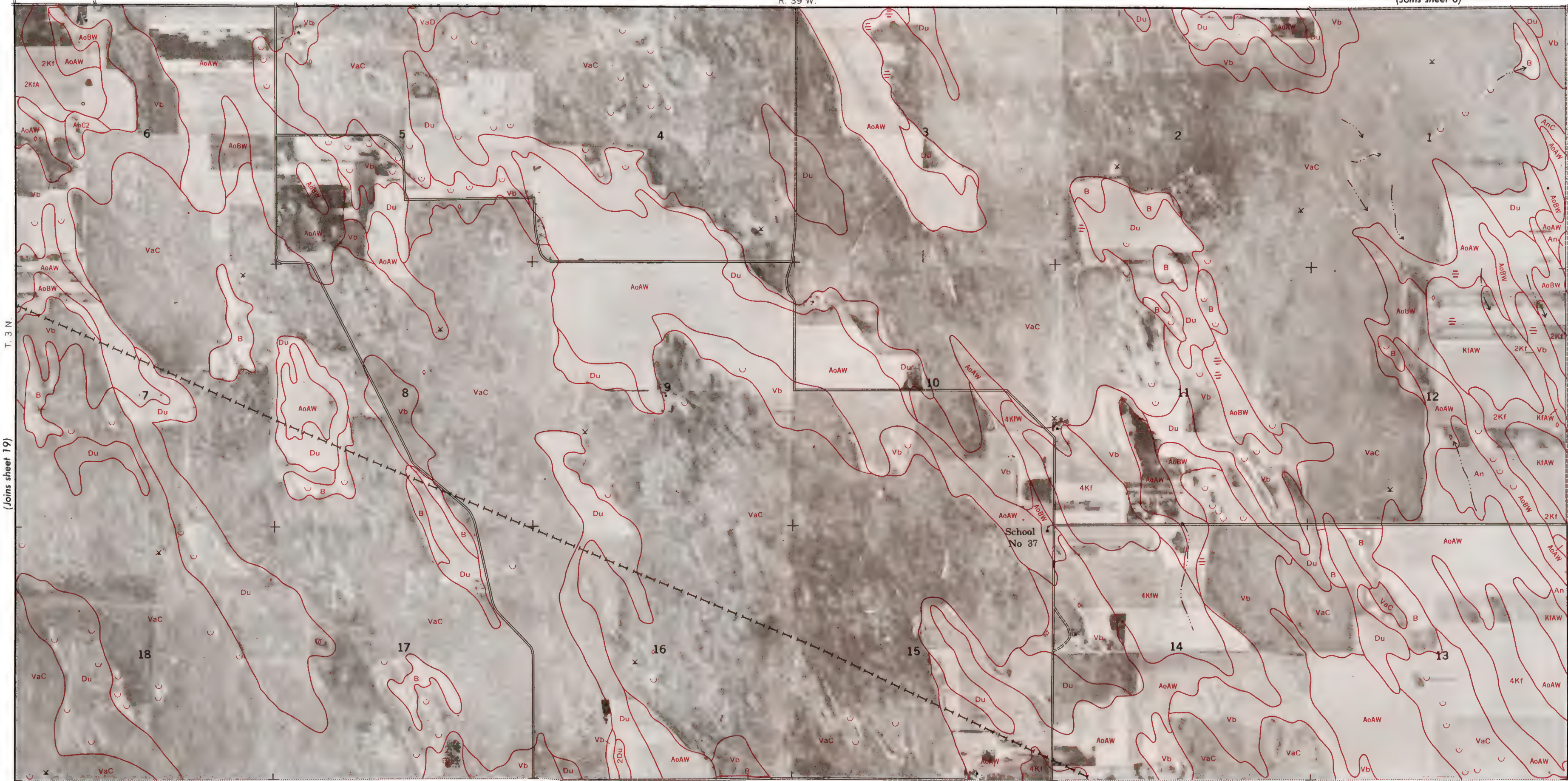


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Range, township, and section corners shown on this map are indefinite.

(Joins sheet 19)

T. 3 N.



(Joins sheet 23)

(Joins sheet 22)



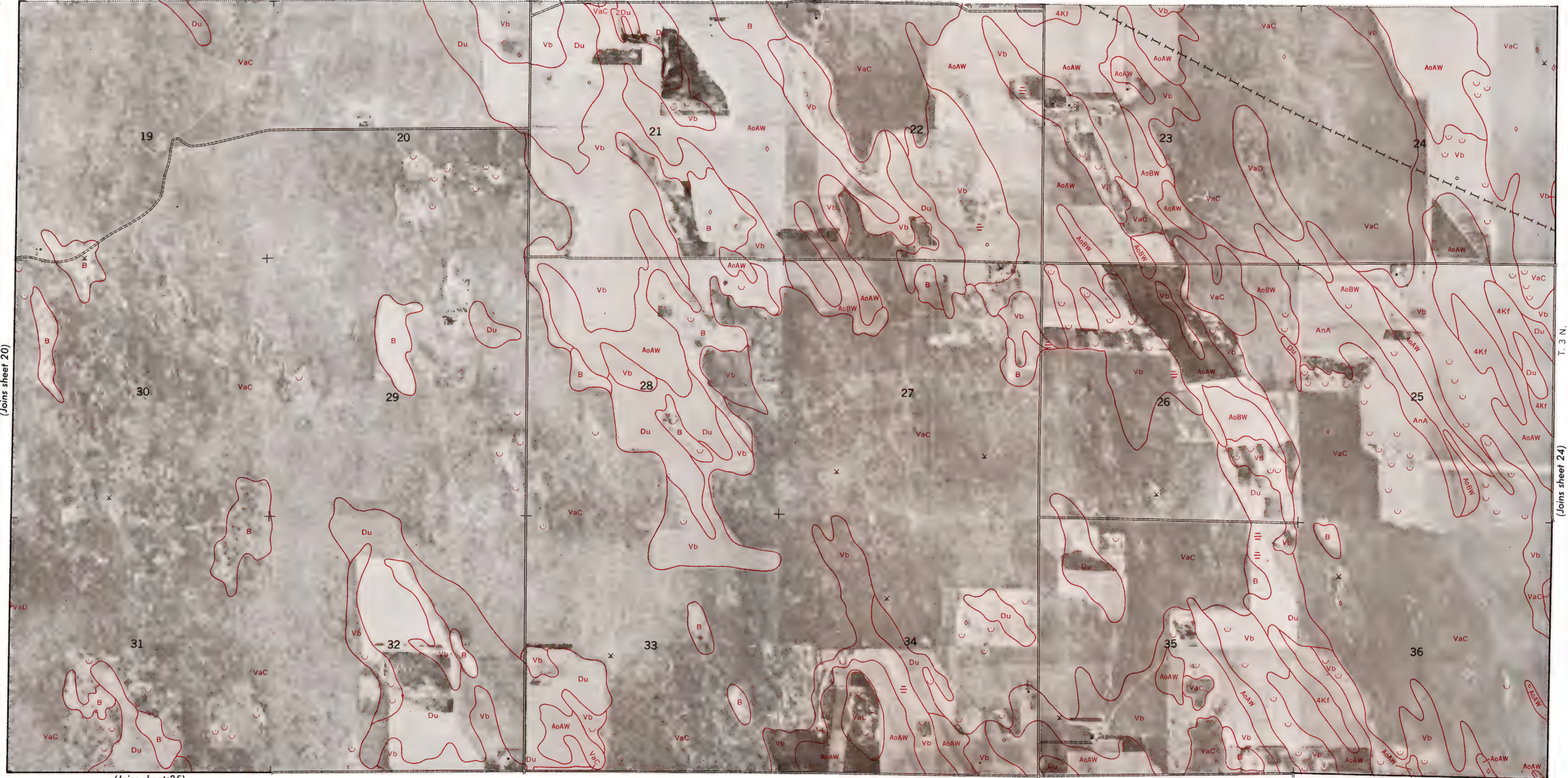
22

(Joins sheet 21)

R. 39 W.



(Joins sheet 20)



(Joins sheet 35)

(Joins sheet 24)

0 1/4 1 Mile Scale 1:20 000 0 5 000 Feet

(Joins sheet 10)

Flow in 1952.
Range, township, and section corners shown on this map are indefinite.



Scale 1:20 000

24

(Joins sheet 23)

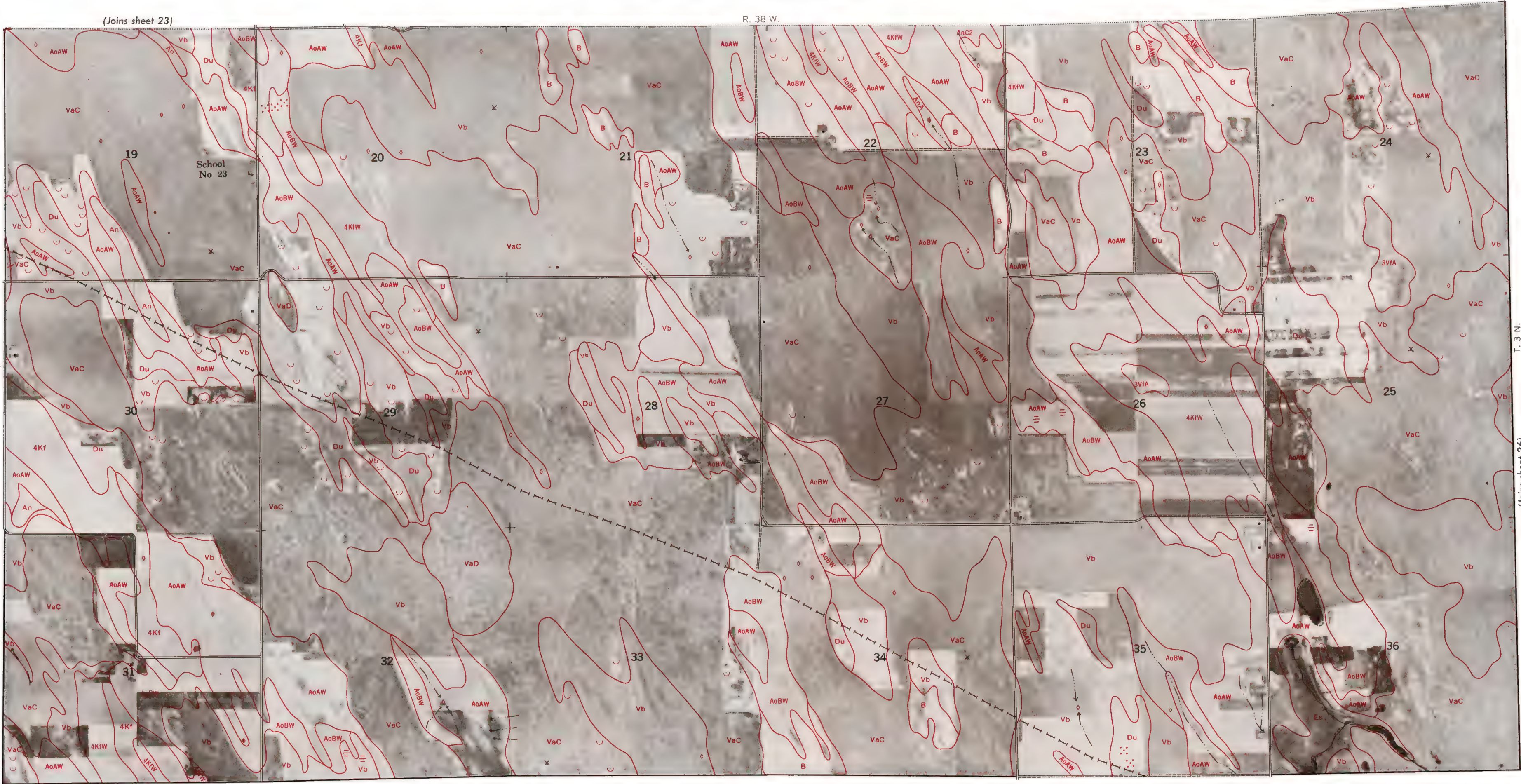
R. 38 W.



(Joins sheet 22)

T. 3 N.

(Joins sheet 26)



(Joins sheet 37)



R. 37 W.

(Joins sheet 12)

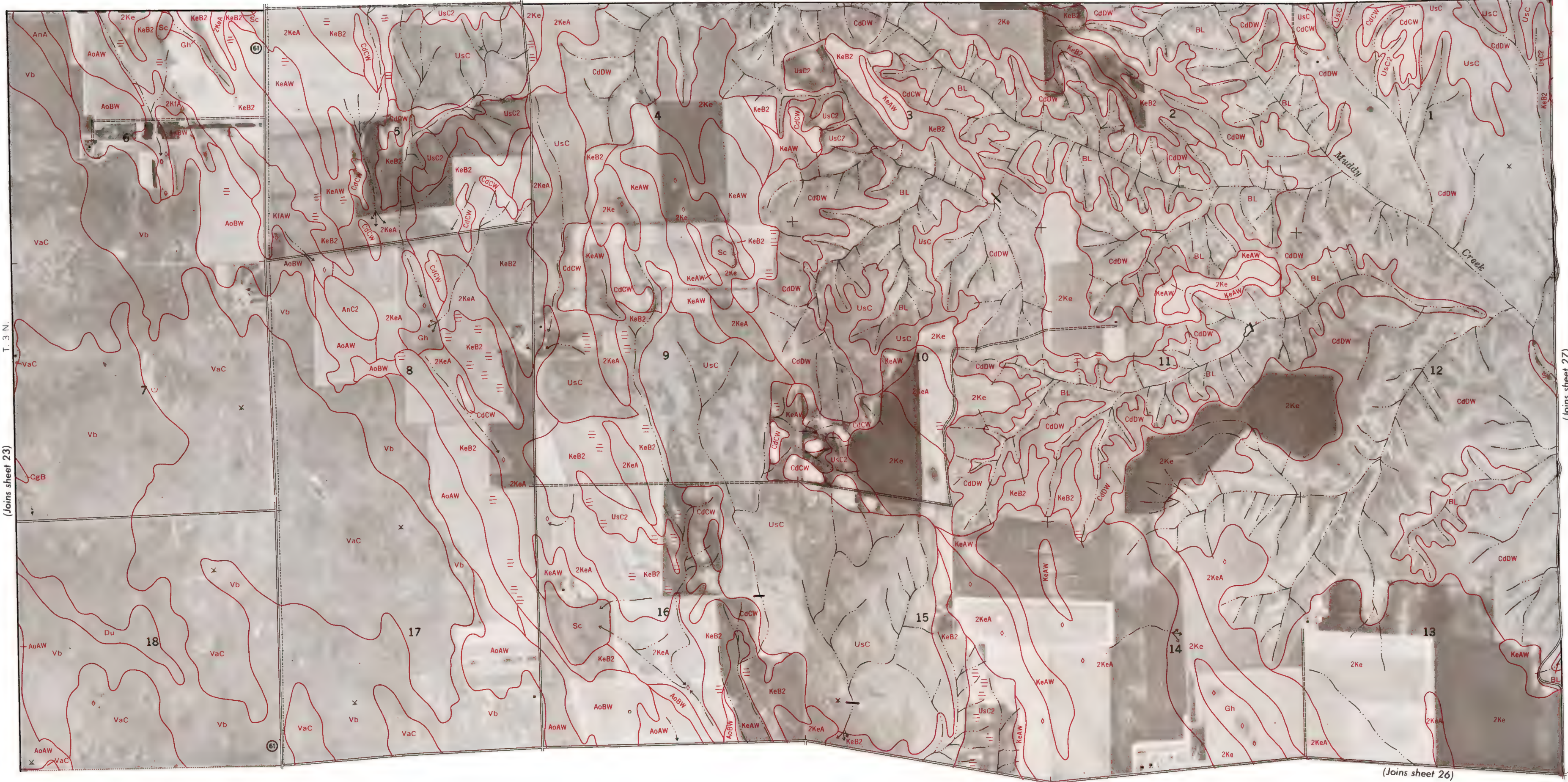


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T. 3 N.

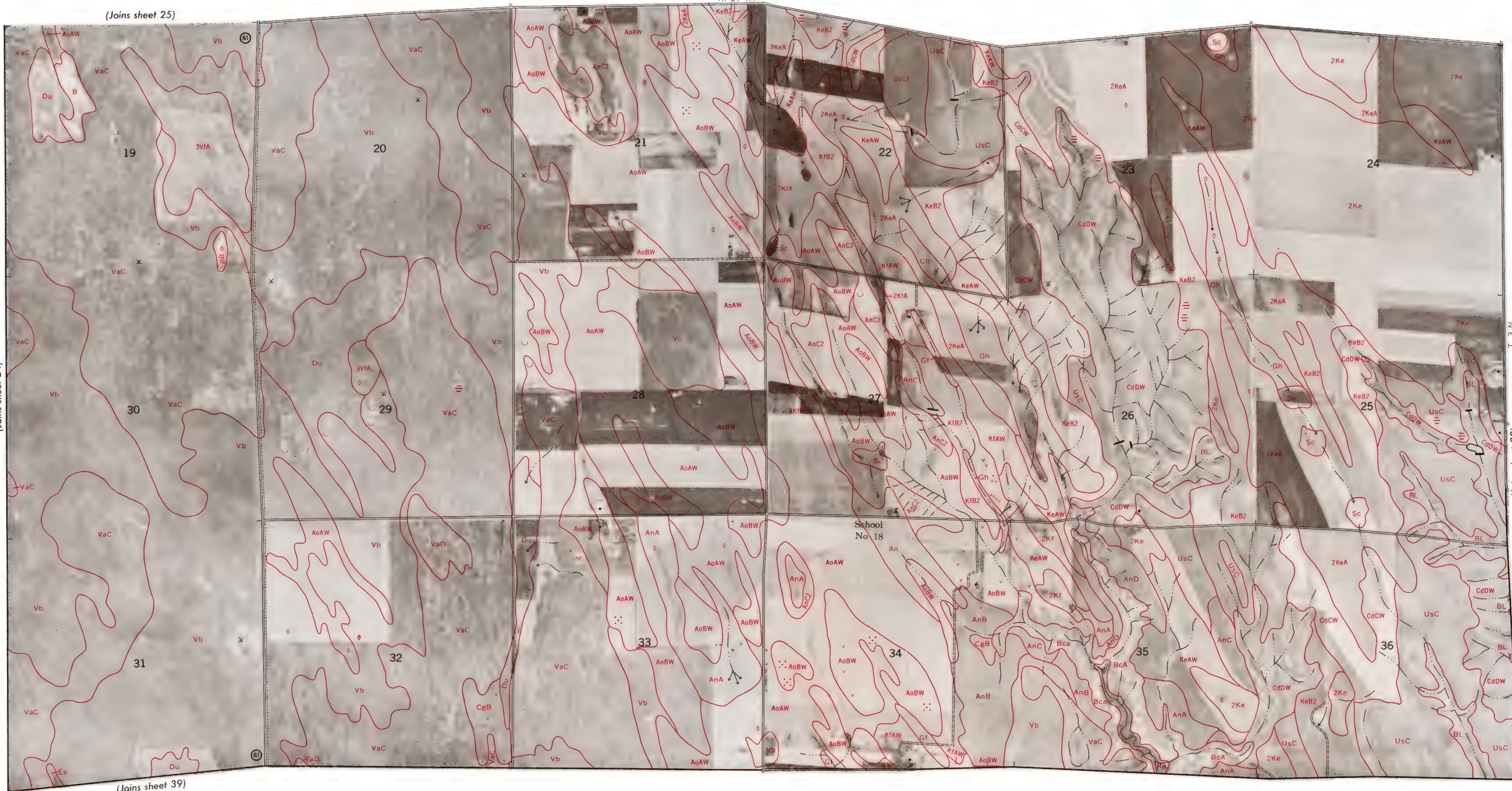
(Joins sheet 23)



(Joins sheet 27)

(Joins sheet 26)





(Joins sheet 27)

28



(Joins sheet 26)



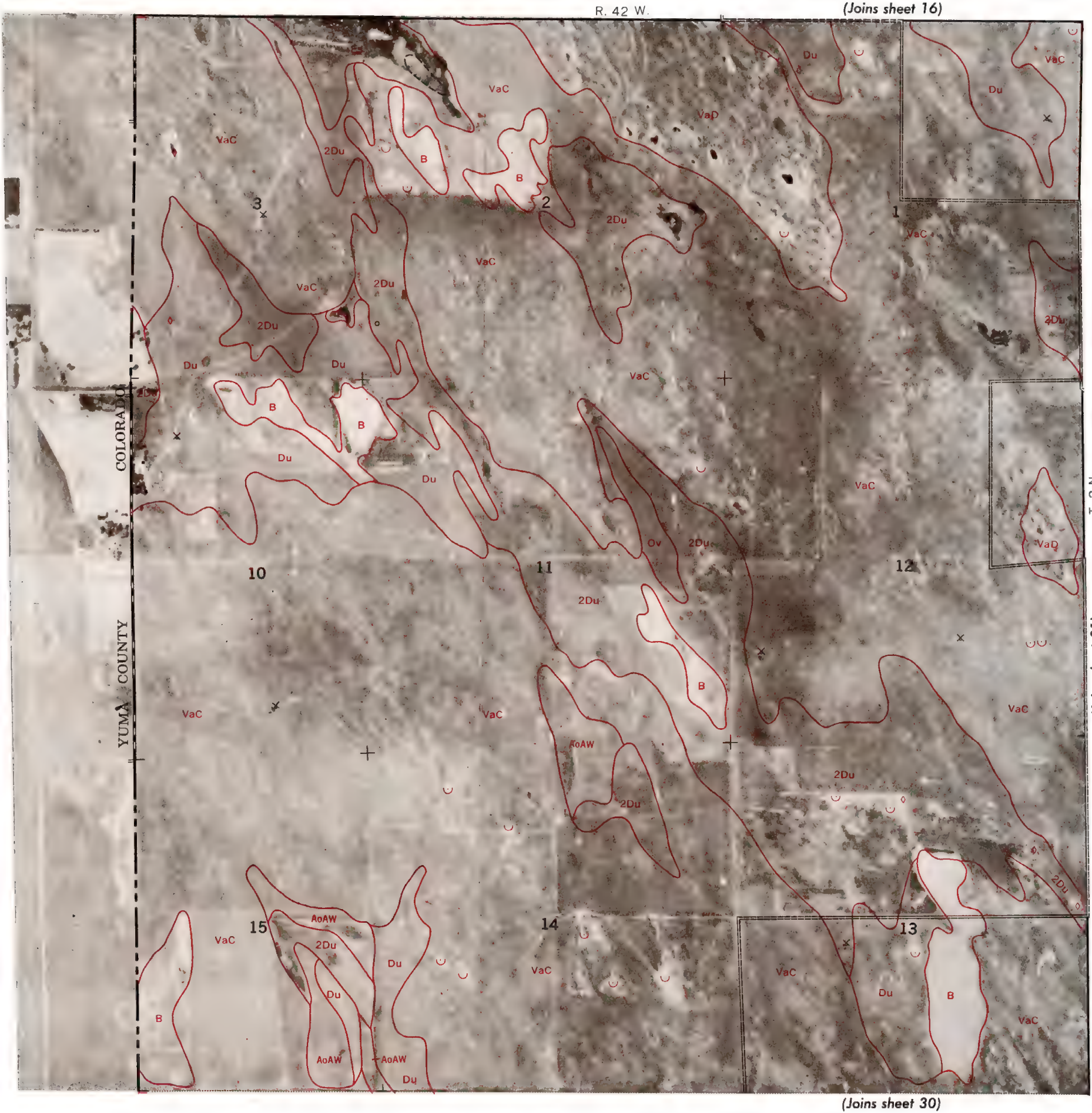
HITCHCOCK COUNTY T. 3 N.

(Joins sheet 41)



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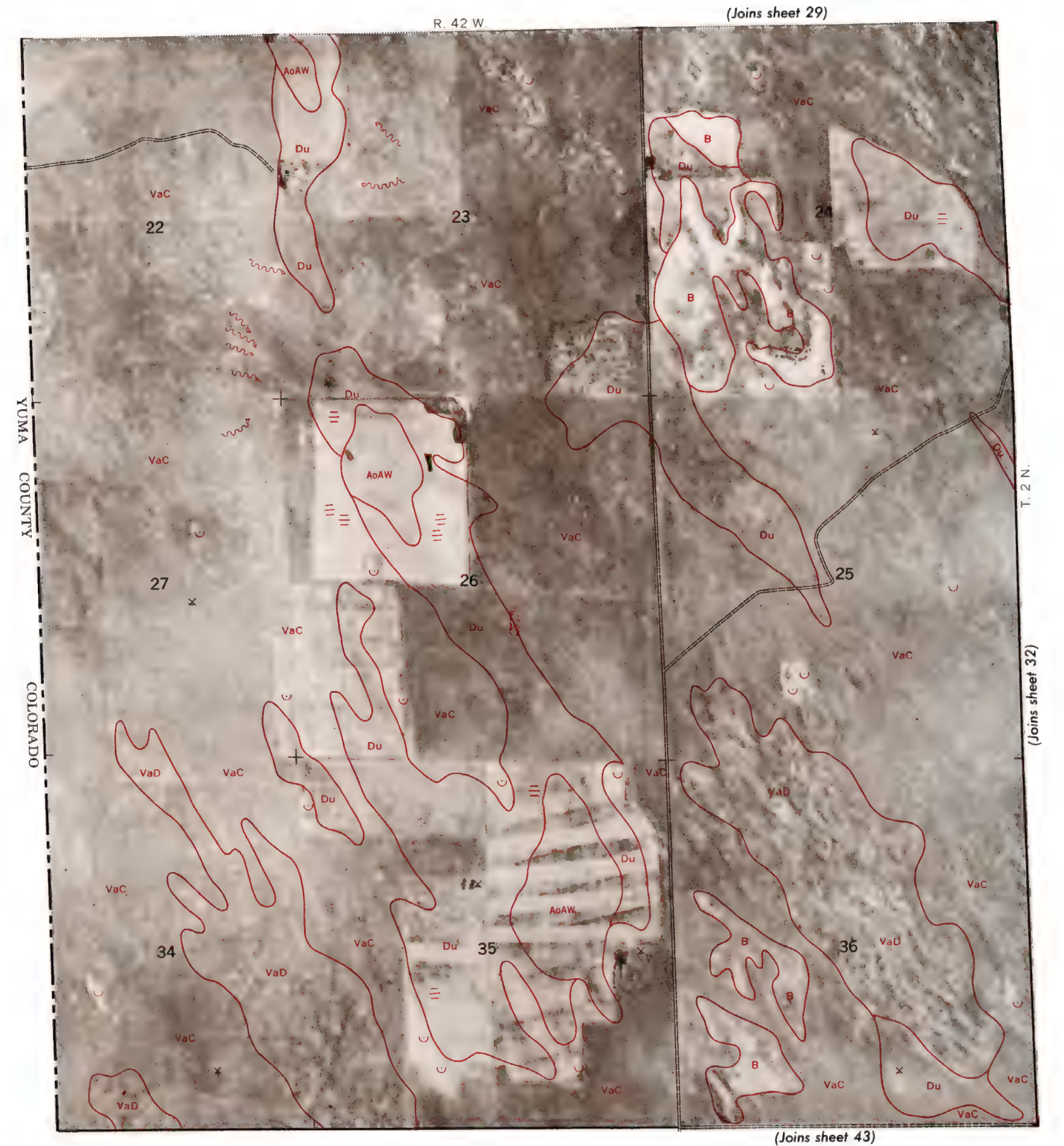
Range, township, and section corners shown on this map are indefinite.



30



0 1/4 1 Mile Scale 1:20 000 0 5 000 Feet



R. 41 W.

(Joins sheet 18)



(Joins sheet 33)

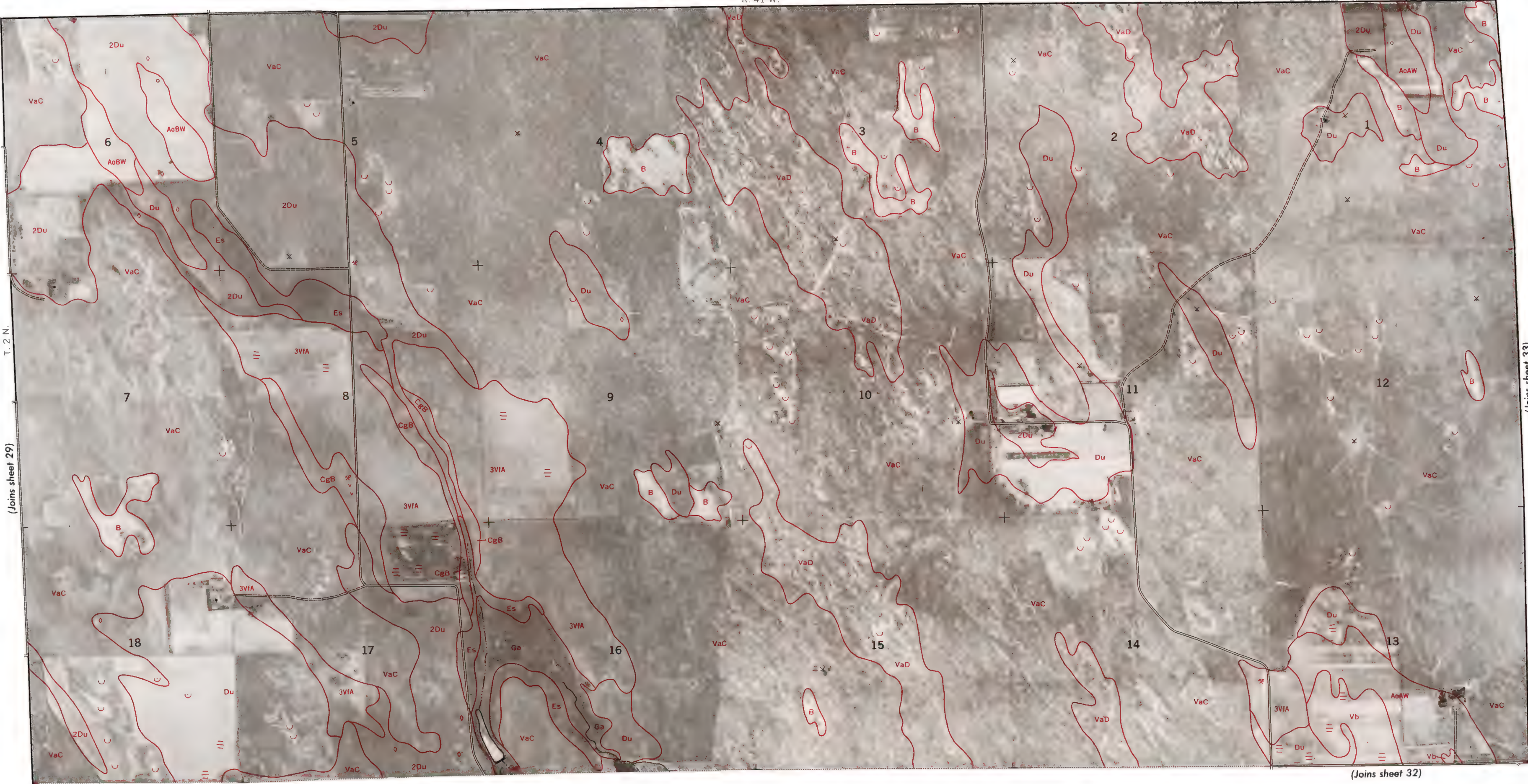
(Joins sheet 32)

(Joins sheet 29)

T. 2 N.

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1952

Range, township, and section corners shown on this map are indefinite.



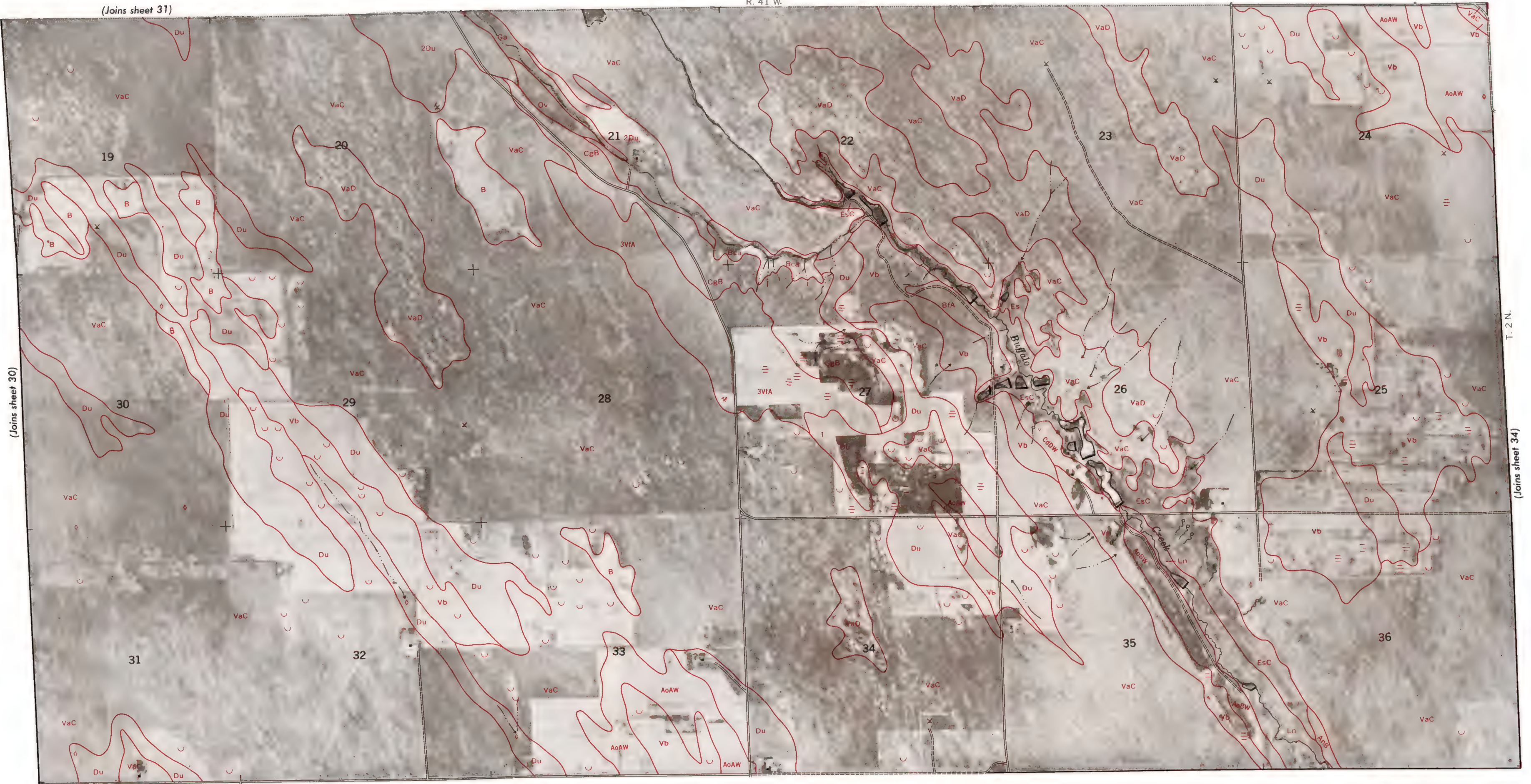
R. 41 W.

(Joins sheet 31)

32



(Joins sheet 30)



T. 2 N.

(Joins sheet 34)

(Joins sheet 45)



R. 40 W.

(Joins sheet 20)

33

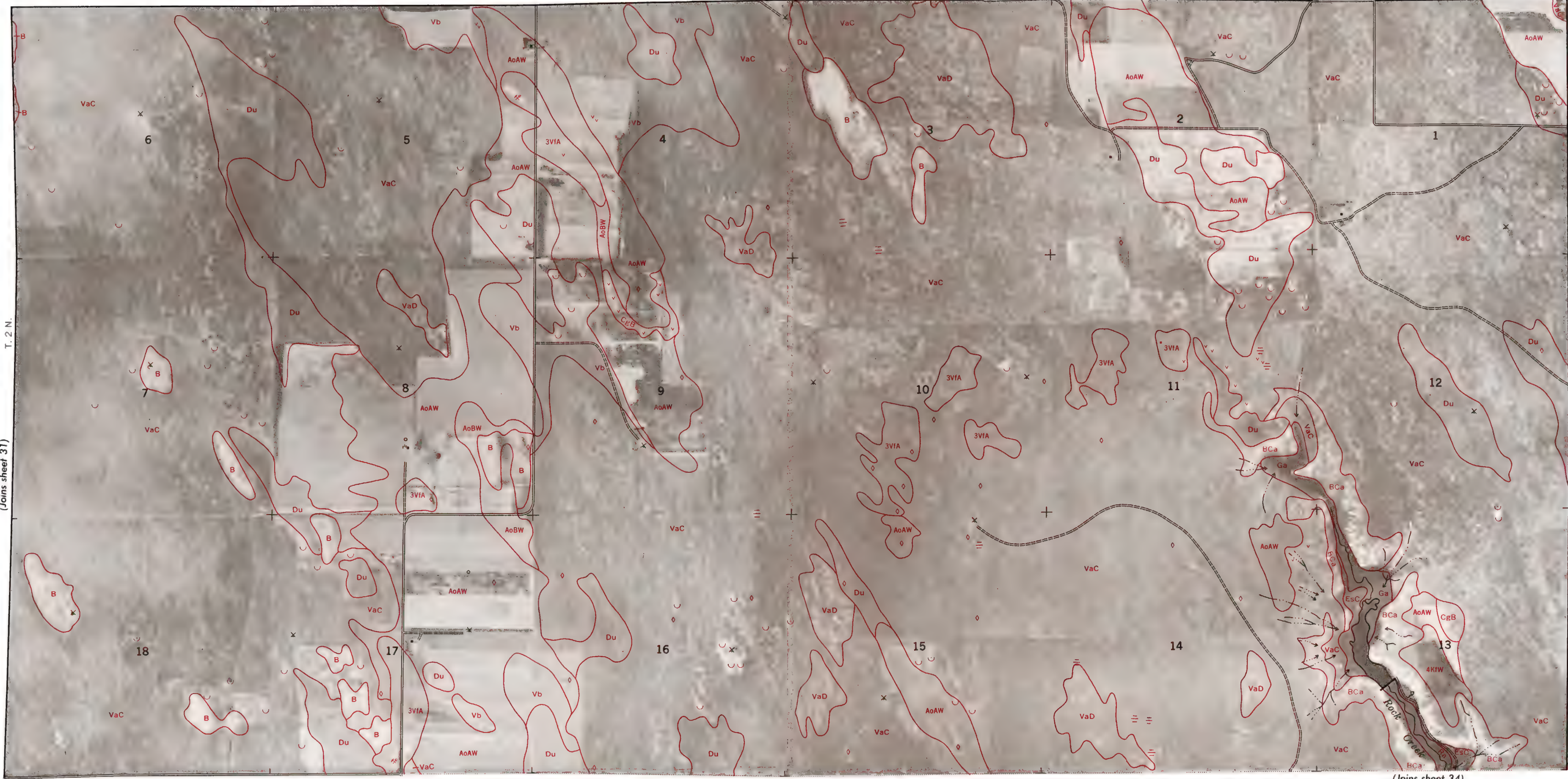


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T. 2 N.

(Joins sheet 31)



(Joins sheet 35)



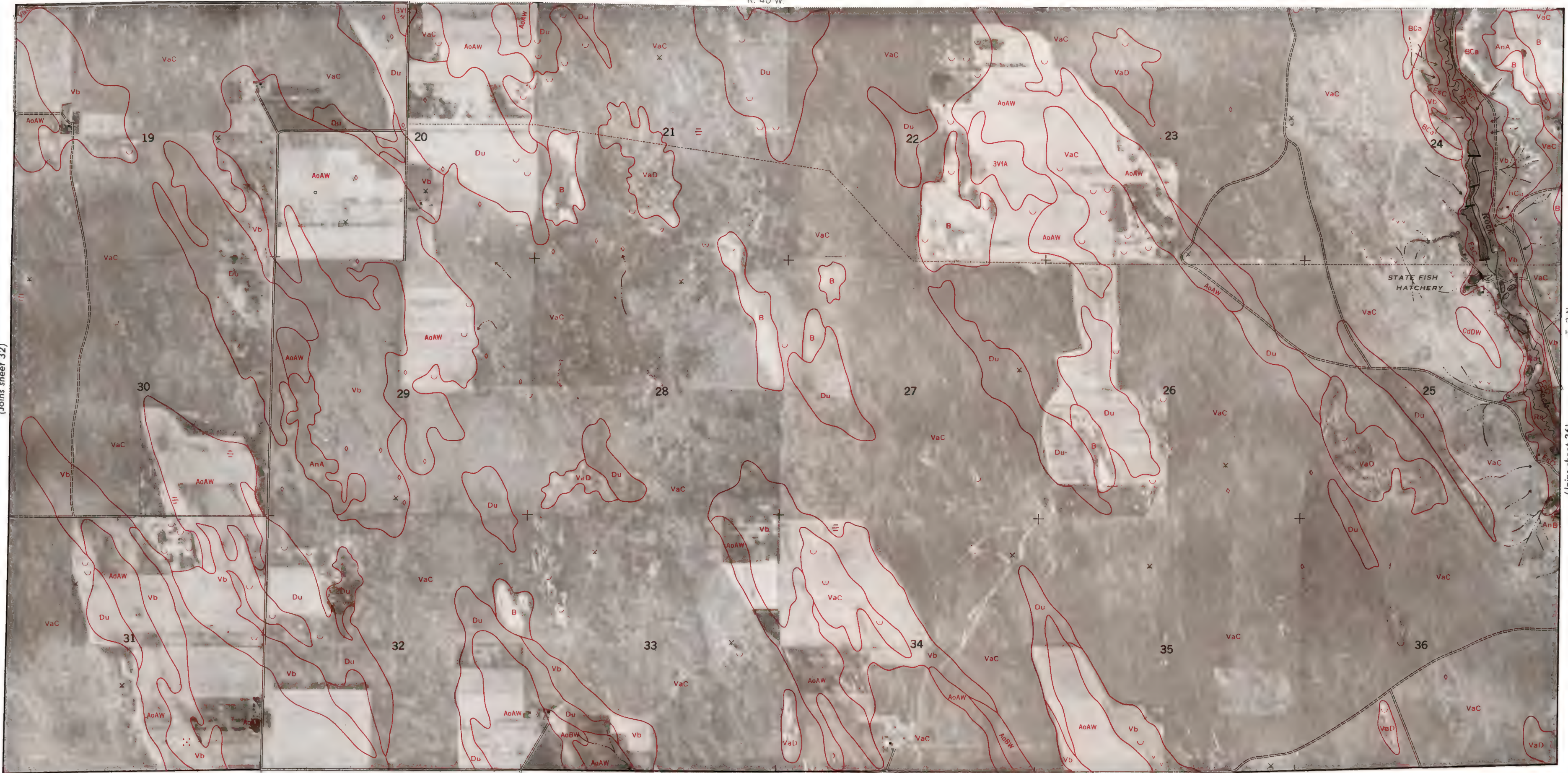
34

(Joins sheet 33)

R. 40 W.



(Joins sheet 32)



T. 2 N.

(Joins sheet 36)

(Joins sheet 47)



R. 39 W.

(Joins sheet 22)

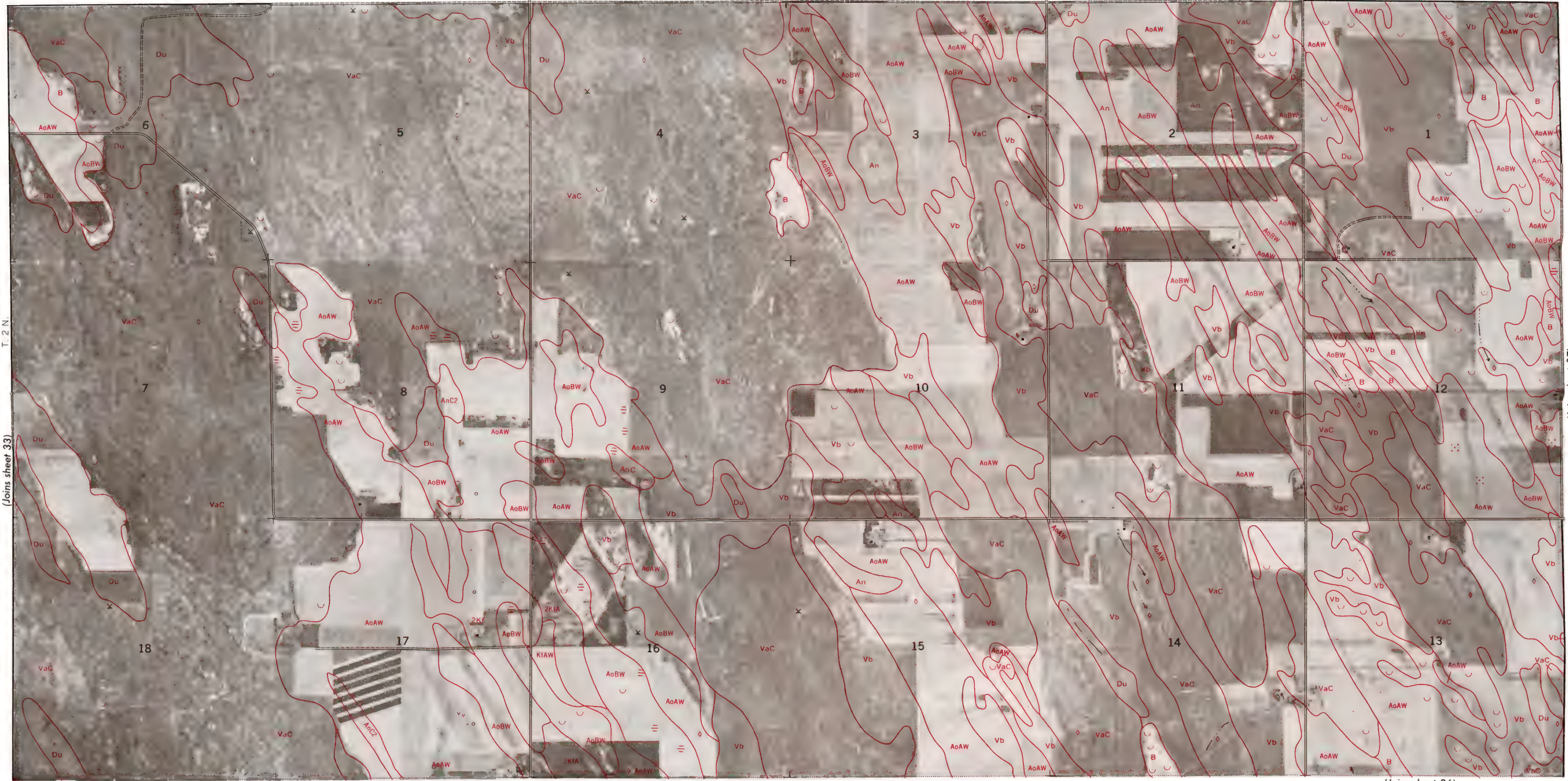


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Range, township, and section corners shown on this map are indefinite.

(Joins sheet 33)

T. 2 N.



(Joins sheet 37)

(Joins sheet 36)

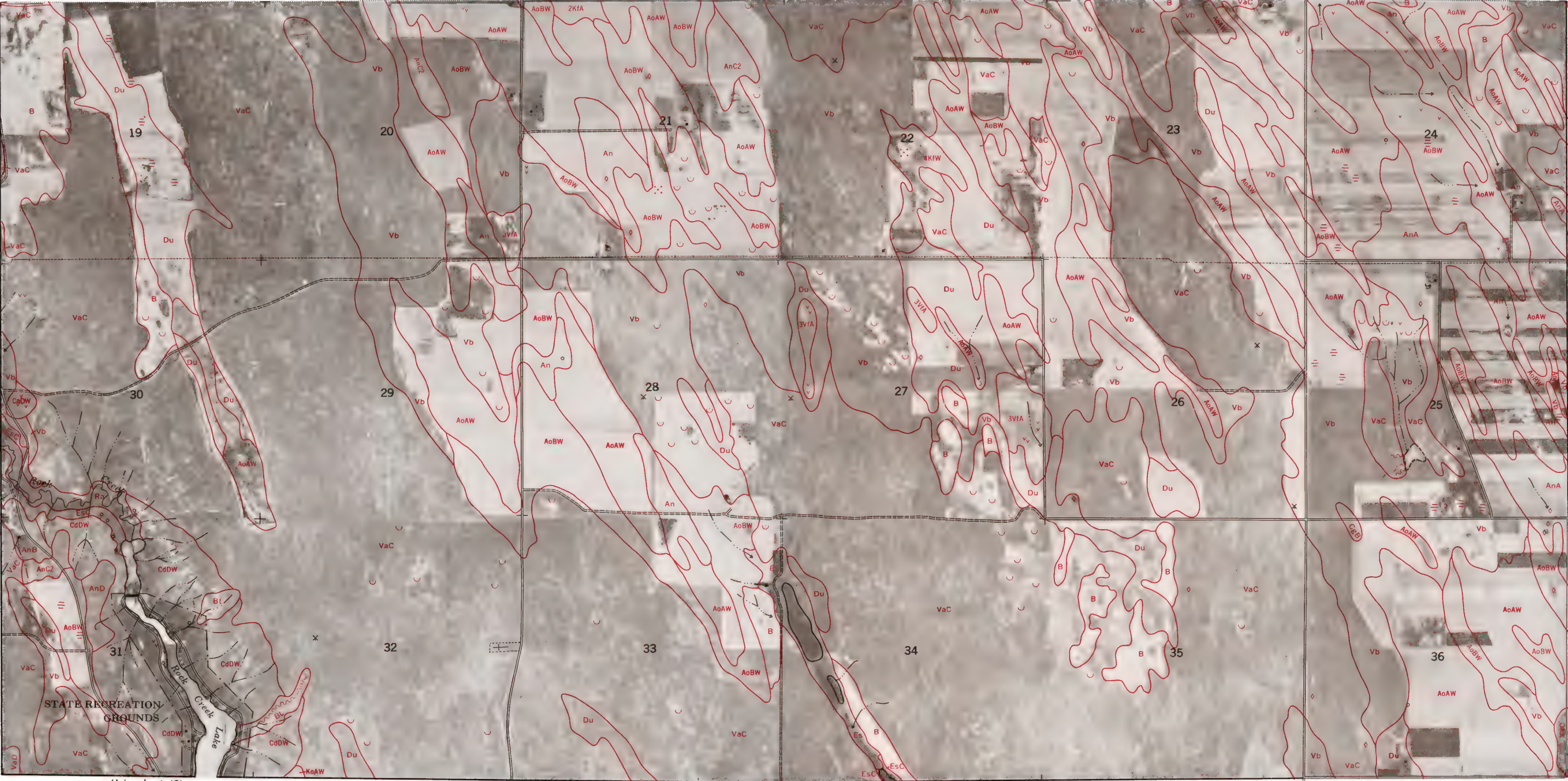


(Joins sheet 35)

R. 39 W.



(Joins sheet 34)



(Joins sheet 49)

T. 2 N.

(Joins sheet 38)





Range, township, and section corners shown on this map are indefinite.

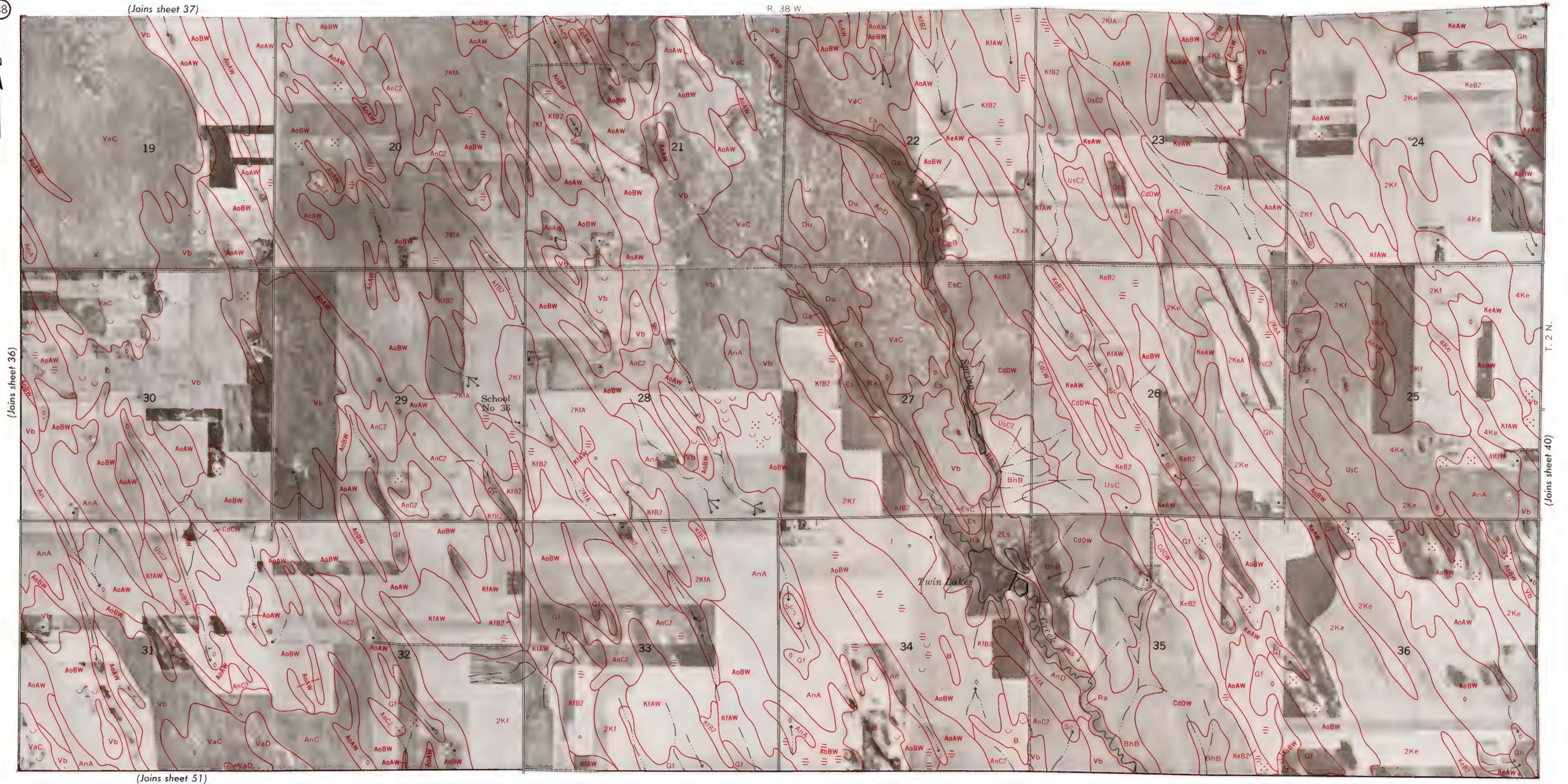
T. 2 N.

(Joins sheet 35)

0 1 Mile Scale 1:20 000 0 5 000 Feet

(Joins sheet 38)

R. 38 W.



1. 2. 1.

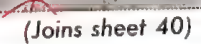
(001-1234567890)



town in 1952.
Range, township, and section corners shown on this map are indefinite.

(Joins sheet 37)

(Joins sheet 41)



R. 37 W.

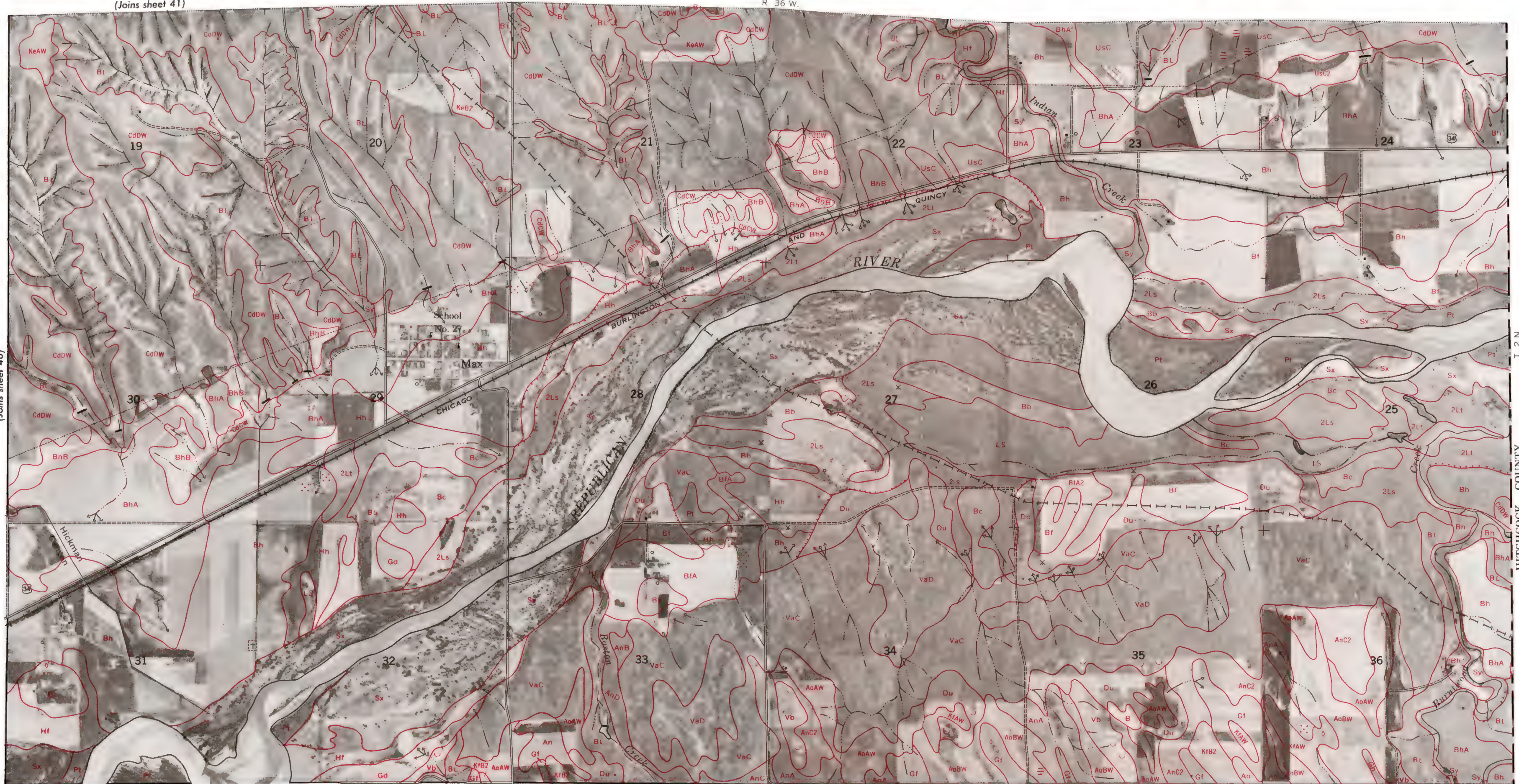
(Joins sheet 38)

T. 2 N.

(Joins sheet 42)

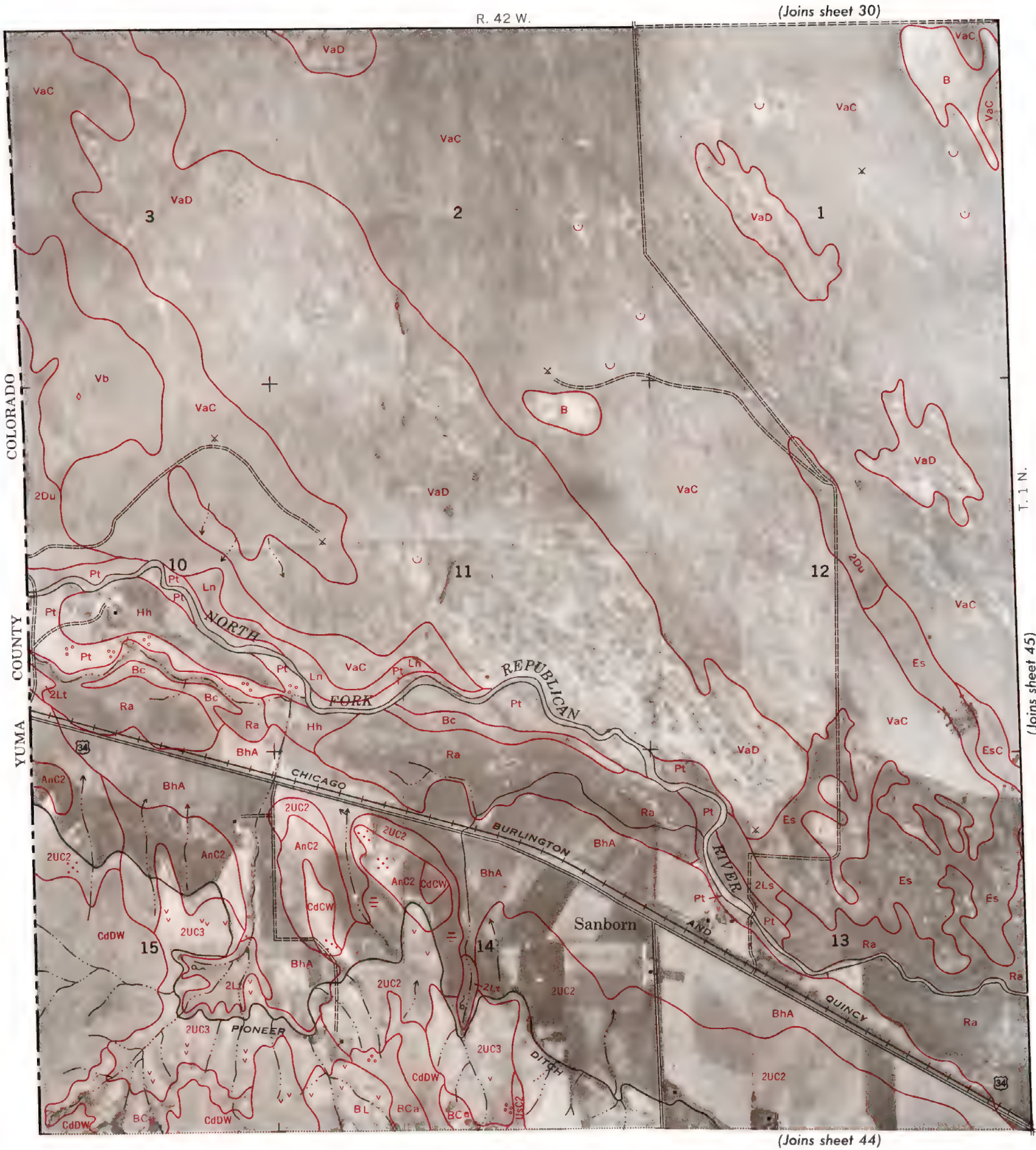
(Joins sheet 53)

Range, township, and section corners shown on this map are indefinite.



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Range, township, and section corners shown on this map are indefinite.



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COLORADO

YUMA COUNTY

CHEYENNE COUNTY

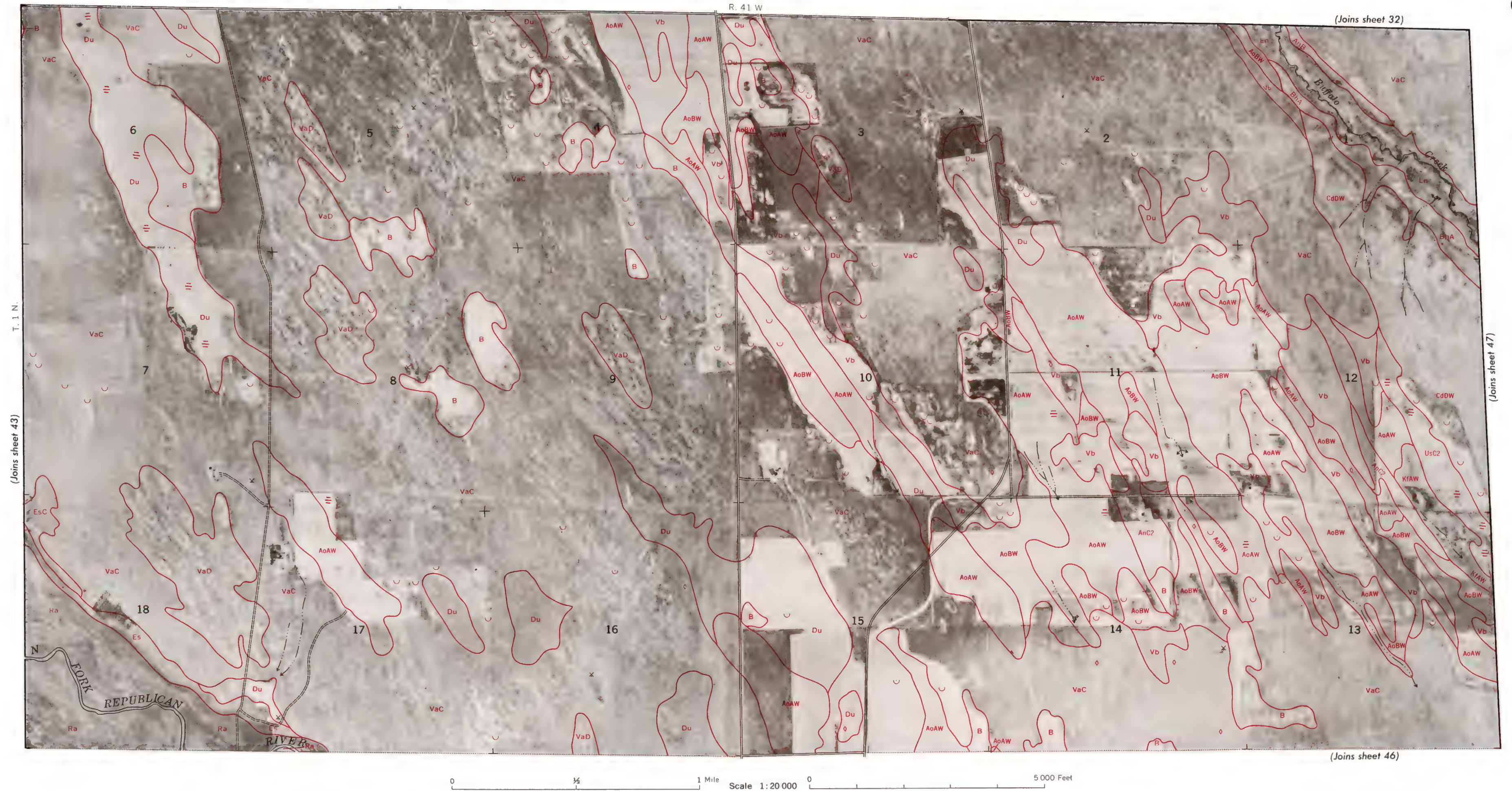
KANSAS

(Joins sheet 46)



Scale 1:20 000

Range, township, and section corners shown on this map are indefinite.



R. 41 W



(Joins sheet 44)

T. 11 N.

(line sheet 18)

CHEYENNE COUNTY

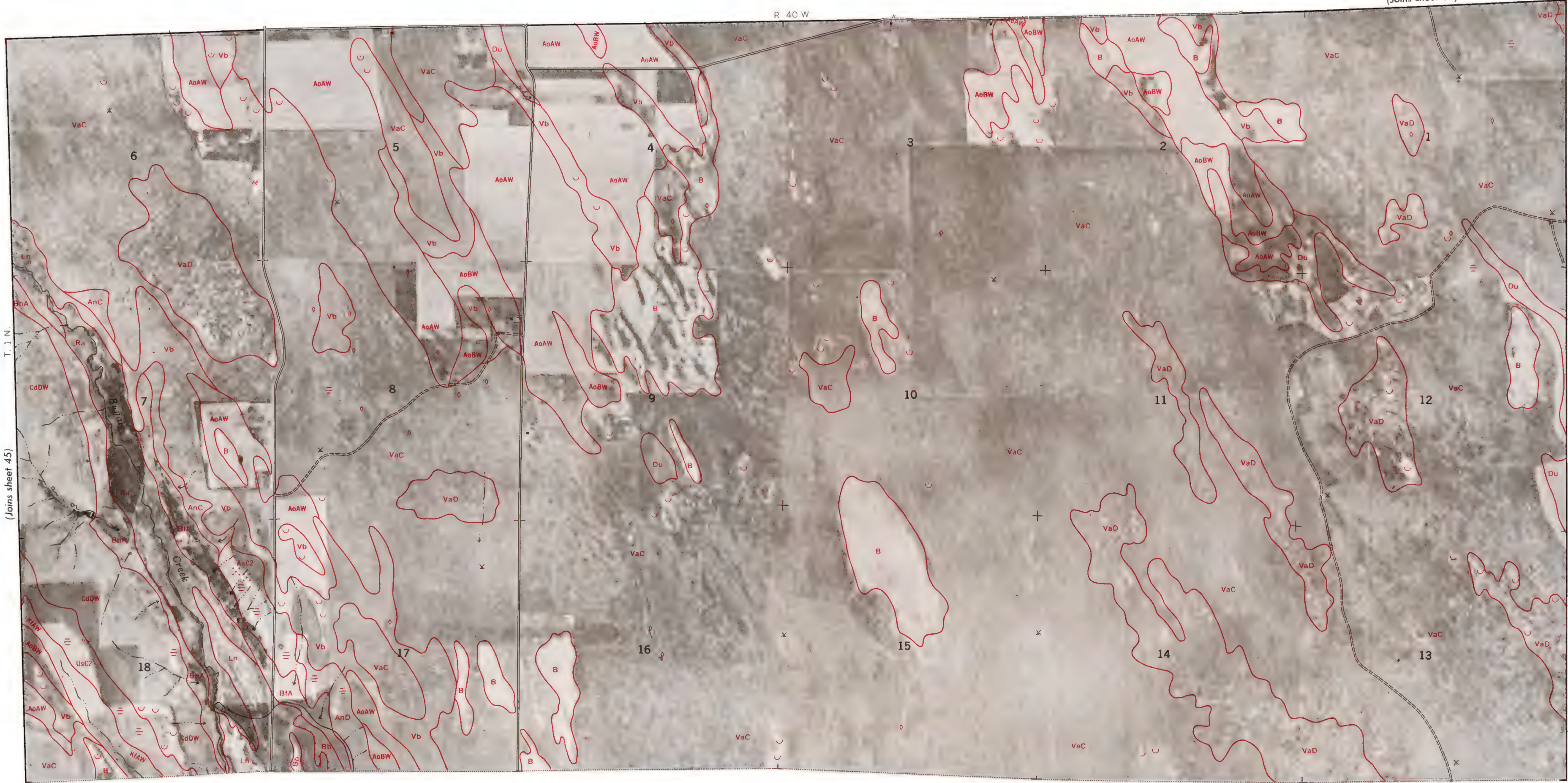
KANSAS





(Joins sheet 45)

(Joins sheet 48)



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs taken in 1952.

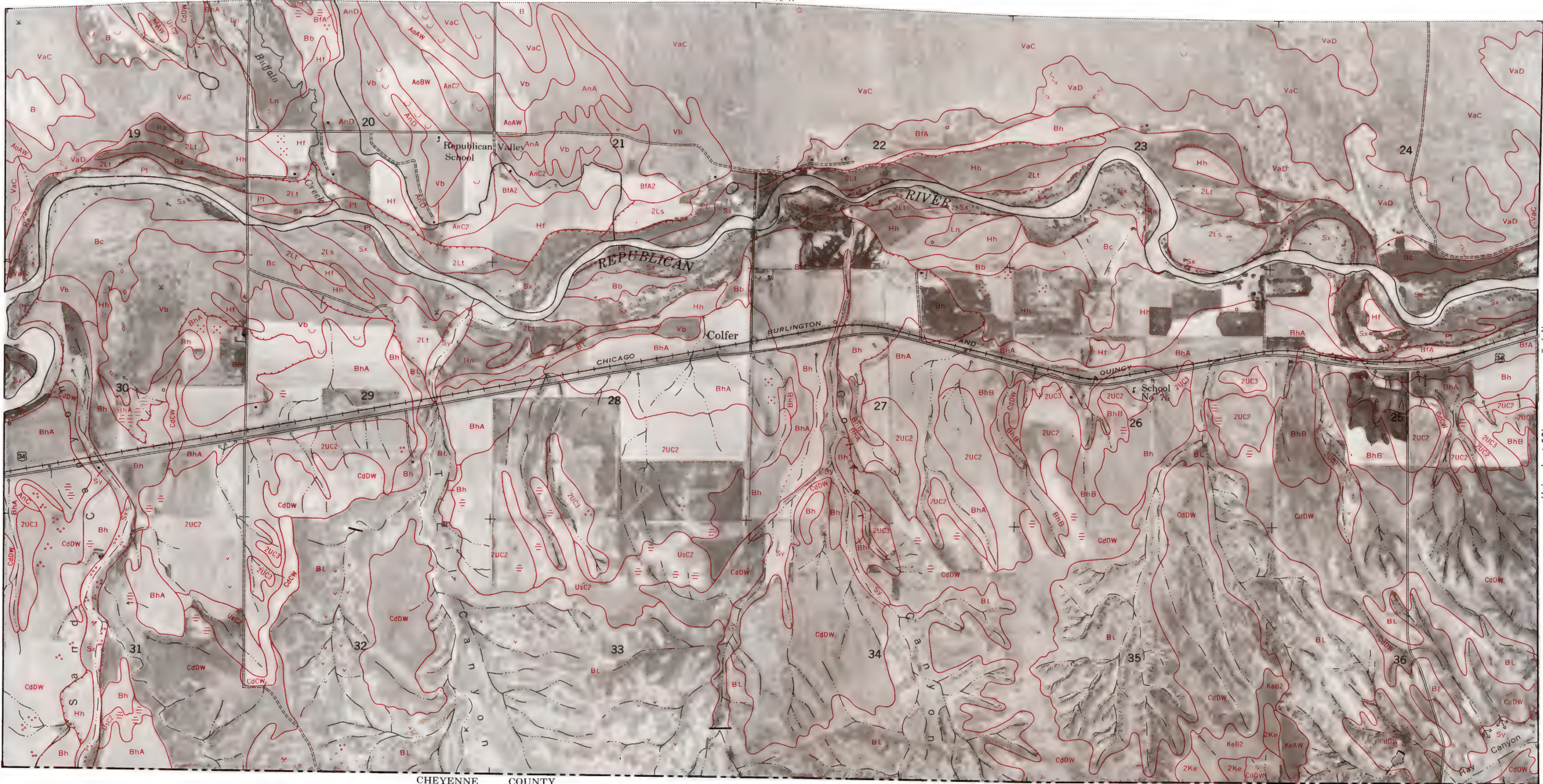
Range, township, and section corners shown on this map are indefinite.

(Joins sheet 47)

R 40 W



(Joins sheet 46)



(Joins sheet 50)

CHEYENNE COUNTY

KANSAS



R. 39W.

(Joins sheet 36)



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1952

Range, township, and section corners shown on this map are indefinite.



(Joins sheet 47)

(Joins sheet 51)

(Joins sheet 50)



50

(Joins sheet 49)

R. 39 W.



(Joins sheet 48)



CHEYENNE COUNTY

KANSAS

0 1/2 1 M Scale 1:20 000 0 5 000 Feet

T. 1 N.

(Joins sheet 52)



(Joins sheet 53)

Scale 1:20 000

5000 feet

1 Mile

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0

(Joins sheet 49)

T. J. N.

Range, township, and section corners shown on this map are indefinite.

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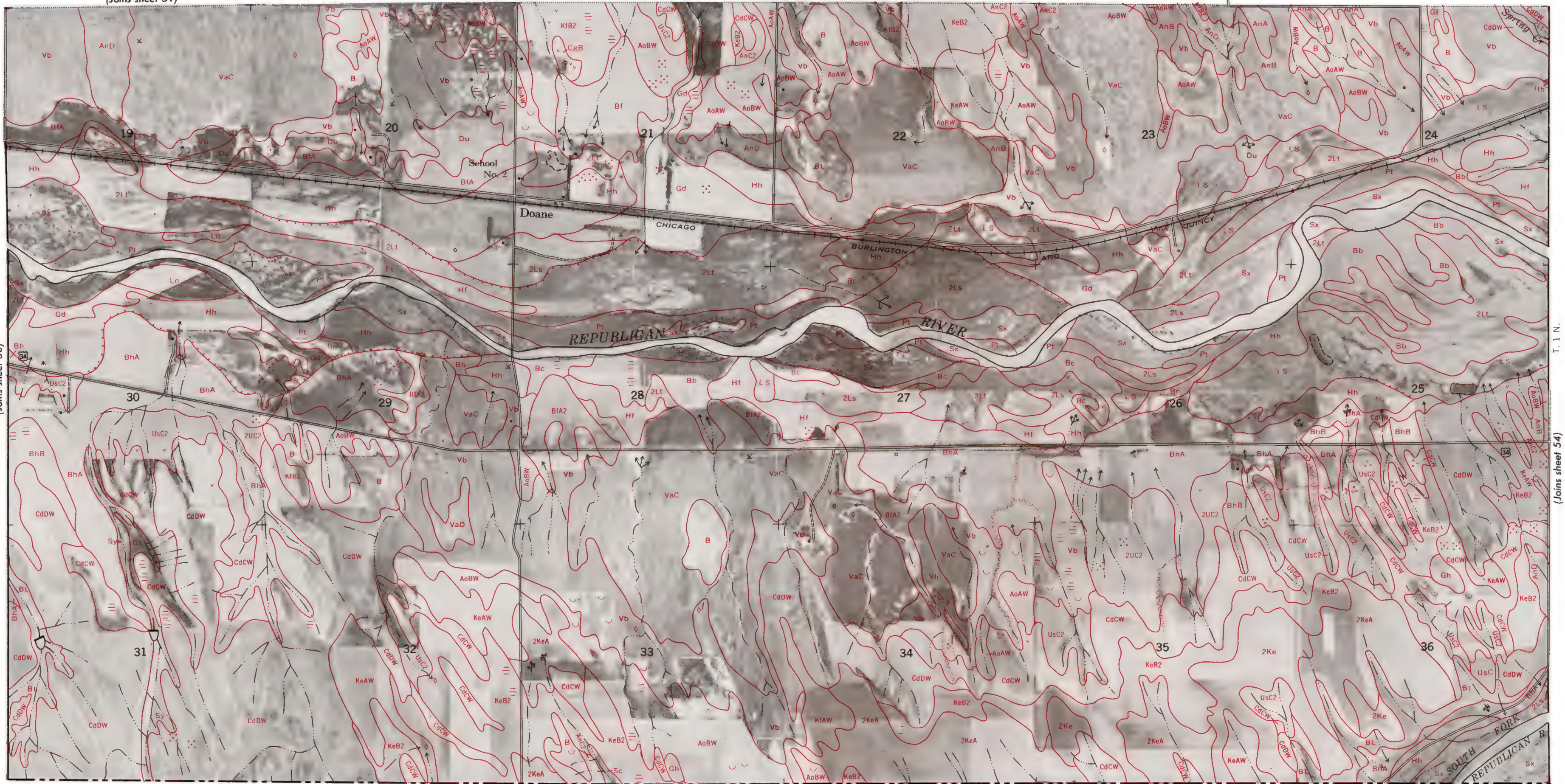
52

(Joins sheet 51)

R. 38 W.



(Joins sheet 50)



T. 1 N.

(Joins sheet 54)

CHEYENNE COUNTY

KANSAS



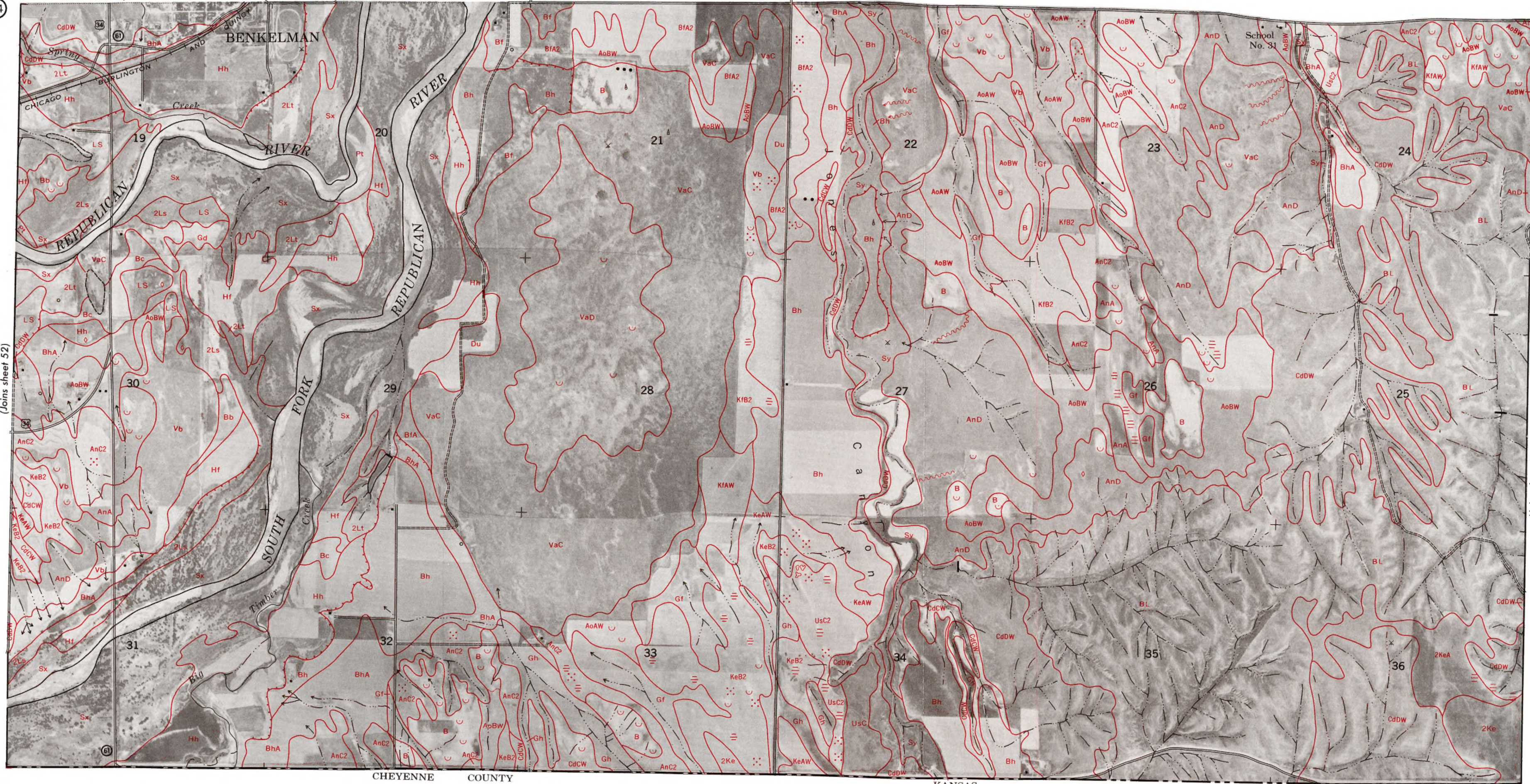
town in 1952.
Range, township, and section corners shown on this map are indefinite.



(Joins sheet 54)



(Joins sheet 52)

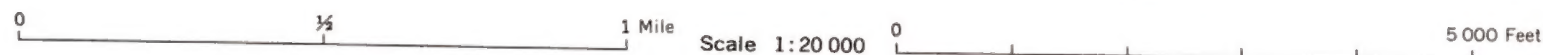


T. 1 N.

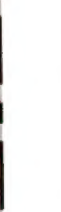
(Joins sheet 56)

CHEYENNE COUNTY

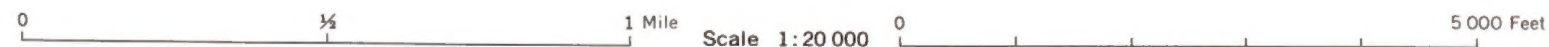
KANSAS



Range, township, and section corners shown on this map are indefinite.



(Joins sheet 56)



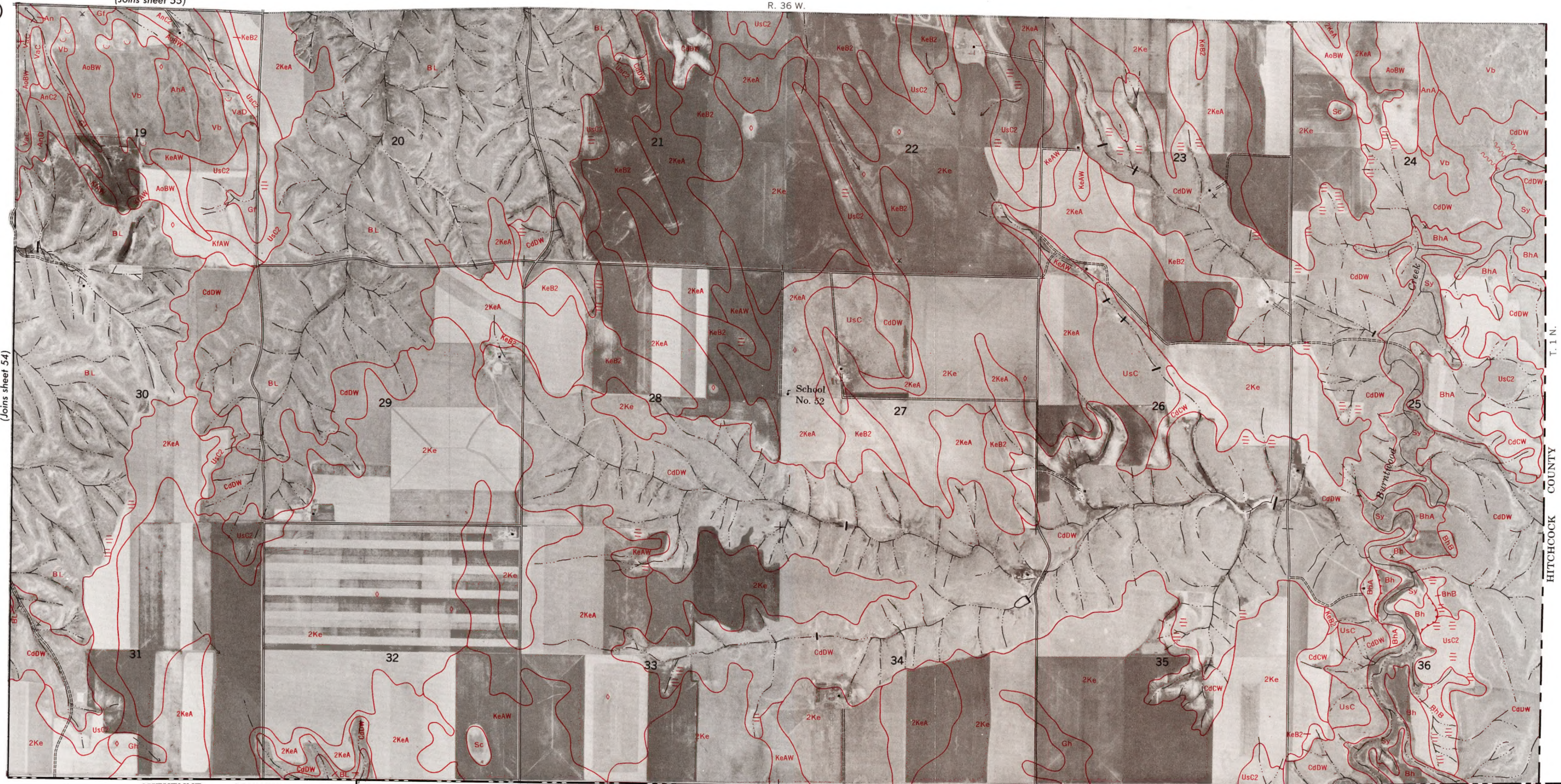
56

(Joins sheet 55)

R. 36 W.



(Joins sheet 54)



T. 1 N.
HITCHCOCK COUNTY

CHEYENNE COUNTY

KANSAS

RAWLINS COUNTY

0 1/4 1 Mile Scale 1:20 000 0 5 000 Feet